This is a digital copy of a book that was preserved for generations on library shelves before it was carefully scanned by Google as part of a project to make the world's books discoverable online.

It has survived long enough for the copyright to expire and the book to enter the public domain. A public domain book is one that was never subject to copyright or whose legal copyright term has expired. Whether a book is in the public domain may vary country to country. Public domain books are our gateways to the past, representing a wealth of history, culture and knowledge that's often difficult to discover.

Marks, notations and other marginalia present in the original volume will appear in this file - a reminder of this book's long journey from the publisher to a library and finally to you.

Usage guidelines

Google is proud to partner with libraries to digitize public domain materials and make them widely accessible. Public domain books belong to the public and we are merely their custodians. Nevertheless, this work is expensive, so in order to keep providing this resource, we have taken steps to prevent abuse by commercial parties, including placing technical restrictions on automated querying.

We also ask that you:

+ *Make non-commercial use of the files* We designed Google Book Search for use by individuals, and we request that you use these files for personal, non-commercial purposes.

+ *Refrain from automated querying* Do not send automated queries of any sort to Google's system: If you are conducting research on machine translation, optical character recognition or other areas where access to a large amount of text is helpful, please contact us. We encourage the use of public domain materials for these purposes and may be able to help.

+ *Maintain attribution* The Google "watermark" you see on each file is essential for informing people about this project and helping them find additional materials through Google Book Search. Please do not remove it.

+ *Keep it legal* Whatever your use, remember that you are responsible for ensuring that what you are doing is legal. Do not assume that just because we believe a book is in the public domain for users in the United States, that the work is also in the public domain for users in other countries. Whether a book is still in copyright varies from country to country, and we can't offer guidance on whether any specific use of any specific book is allowed. Please do not assume that a book's appearance in Google Book Search means it can be used in any manner anywhere in the world. Copyright infringement liability can be quite severe.

About Google Book Search

Google's mission is to organize the world's information and to make it universally accessible and useful. Google Book Search helps readers discover the world's books while helping authors and publishers reach new audiences. You can search through the full text of this book on the web at `http://books.google.com/`

600030403G

G. 64.

E. BIBL. RADC

~~18~~
~~A. 5~~
4

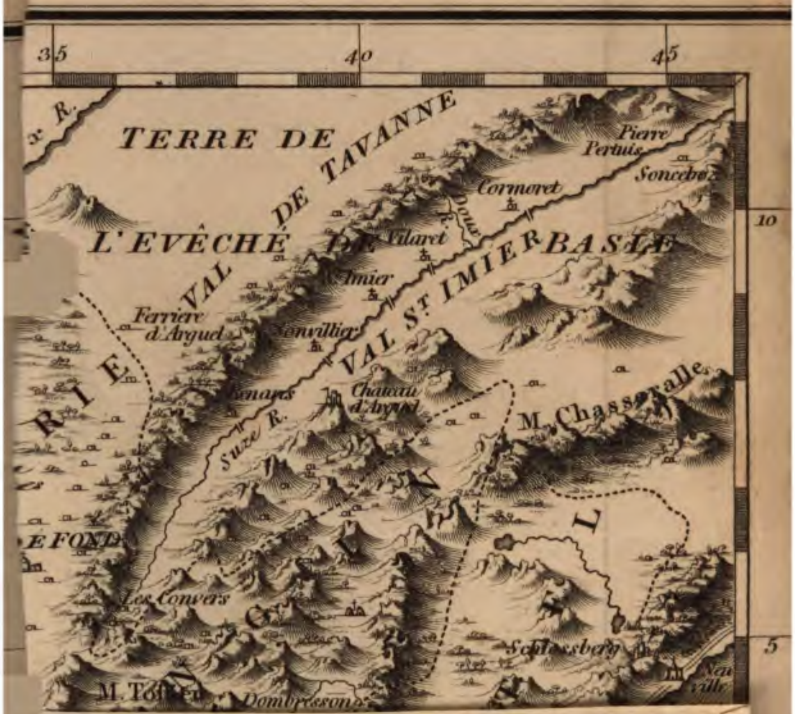
a 12
3
18

1886

e

RAVELS

AND,


35
40
45
10
5
x R.
TERRE DE
L'EVÊCHÉ DE
BASLE
VAL DE TAVANNE
Pierre Pertuis
Soncebo
Cormoret
Doux R.
Vilaret
St. Imier
VAL St. IMIER
Ferriere d'Arguel
Sonvillier
Renans
Chateau d'Arguel
Suze R.
M. Chasseralle
RIE
E FOND
Les Convers
Schlossberg
Neu ville
M. Tête
Dombresson
N
G
L

GEOLOGICAL TRAVELS

IN SOME PARTS OF

FRANCE, SWITZERLAND,

AND

GERMANY.

BY J. A. DE LUC, F.R.S.

IN TWO VOLUMES.

ILLUSTRATED WITH TWO TOPOGRAPHICAL MAPS

TRANSLATED FROM THE FRENCH MANUSCRIPT.

VOL. I.

LONDON;
PRINTED FOR F. C. AND J. RIVINGTON,
NO, 62. ST. PAUL'S CHURCH-YARD;
By Law and Gilbert, St. John's Square, Clerkenwell.

1813.

2. The 1st Vol. of M. de Saussure's Travels soon afterwards appeared. Of the light which has been diffused in Geology by that work, I have frequently spoken in my subsequent writings, and especially in my *Lettres to M. de la Metherie* inserted in his *Journal de Physique*; and I here repeat, with a still firmer conviction, that I consider M. de Saussure as having laid down in this science such fundamental principles as can never be subverted. But with these he unfortunately associated, from the first, some less correct ideas, which not only obstructed his own progress, but have even impeded that of the above essential principles in the minds of other naturalists.

3. He began his interesting descriptions by the *Lithology* of the countries, surrounding the *Lake of Geneva;* where naturalists must see with astonishment what great variety prevails among the stones, with which the surface of the ground is every where overspread, with respect to their genera and species, while, at the same time, they are of every size, from the smallest gravel to masses of enormous bulk; all foreign to the soils in which they are found, sometimes at a considerable depth. My brother and I had long been struck with this fact, without being able to account for it.

4. When any great phenomenon is first observed in a spot where it is accompanied by particular circumstances, the discovery of its cause is commonly

attempted from those circumstances; and this, in general, leads into error. Before we confidently indulge the first ideas which are suggested to our minds by the examination of its local situation, we ought to seek for the same phenomenon in other places; that we may know whether it is constantly attended by the circumstances on which our judgment is founded, and whether to these any new ones are added. It is not until after we have seen a phenomenon in many places, and have every where scrupulously observed its circumstances, that we can discover which are those that always accompany it, and distinguish them from those that are merely accessory; a most essential distinction; for the true characters of the cause of which we are in search are determinable only from the former.

5. M. de Saussure, not having extended his observations to places sufficiently different from each other, considered only one circumstance, namely, that the stones in question were of the same *class* with those which compose the central chain of the *Alps;* whence he therefore concluded them to have been brought by a catastrophe, very real in itself, as I shall hereafter shew, but not capable of producing such effects as he ascribes to it in the following passage, § 210. "The waters of "the ocean, in which our mountains were formed, "still covered a part of those mountains, when a "violent concussion of the globe suddenly opened "large vacant cavities, and occasioned the rupture

“ of the rocks. The waters, rushing down towards
“ these abysses with a violence proportional to the
“ height at which they were at that time standing,
“ excavated deep vallies, and carried along with
“ them an immense quantity of earth, sand, and frag-
“ ments of every kind of rock. These substances,
“ in a state of semi-liquidity, being impelled by
“ the weight of the waters, accumulated to the
“ height at which we still see many of the above
“ fragments dispersed.” . . . . . §. 212. “ The final
“ proof of this explanation is that none of these *large*
“ *blocks* are found in the *vallies* of the *Jura*, which
“ are situated *behind* the high *ridge* forming the
“ border of those mountains on the side towards
“ the *Alps;* for example, in the *vallies* of the country
“ of *Neufchatel*, and in those of *Franche Comté*.
“ But there are considerable accumulations of them
“ in all the breaches of this ridge, wherever an
“ entrance has been opened through defiles to the
“ currents arriving from the *Alps*.”

6. I had before observed *blocks* of *granite* in these very countries, and in situations in which M. de Saussure supposed that none were to be found: and at the time when this 1st Vol. of his Travels appeared, I had already published my *Lettres sur l'Histoire de la Terre et de l'Homme*, wherein I had described vast countries over which were scattered immense quantities of *blocks* and *gravels* of *primordial stones*, at a great distance from all mountains of their own kinds; whence I had been led

to the idea unfolded in that work: that during the catastrophes to which, as I was already convinced, the *secondary strata* must have been subjected, in consequence of the *subsidence* of vast portions of their mass in *caverns*, the *air* confined within the latter, being violently compressed, had ejected fragments of the inferior stones; an explanation equally applicable to the *blocks* of *granite* in the *Jura*. I could not hope, however, that M. de Saussure would go to observe the countries which had suggested to me this system; and as I was unwilling to trust to my memory with respect to those whence he had deduced his own, I became desirous to revisit the latter.

7. But to the above motive, another was added by this same 1st Vol. of M. de Saussure's Travels. Those who have read my first work with any attention may recollect that, though I had often travelled in the *Alps*, the *Apennines*, and the *Hartz*, I had not been able to form any idea with respect to the construction of mountains of that class: I would not decide that they belonged to the *primitive* construction of the globe, and I therefore did not adopt the designation of *primitive*, by which they were at that time commonly distinguished; I called them *primordial*, in order only to express that they were *anterior* to those termed *secondary:* these very expressions, however, were deficient in correctness when applied to *mountains;* as I shall again explain in the sequel.

8. Not understanding any thing of the structure of the *mountains* which I named *primordial*, it had not occurred to me to investigate the *origin* of the substances of which they were composed: but the case was different with respect to the *mountains* called *secondary*, containing *organized bodies*, chiefly *marine*. From this circumstance, it was necessary to admit that the substances which from the mass of their strata had been successively deposited on the bed of the *sea*, while, from the changes in the nature of marine animals, various races had succeeded each other on the same parts of that bed. But whence had these substances been derived? This was another of the points on which I had not been able to form any distinct idea; but as, though the real cause of a phenomenon may not be comprehended, the fallacy of certain supposed causes may yet be clearly perceived, I even then refuted two ideas which many geologists had adopted from M. de BUFFON; firſt, that the substance of the *calcareous strata* had originated in the *detritus* of *marine shells* and *madreporæ;* secondly, that *sand*, whether loose or indurated in strata, was the *detritus* of *granite* and other stones of the same class: two hypotheses which obstructed the road to all discoveries, and which were refuted by M. de Saussure as well as by myself.

9. After having particularized, in this first work, the points which I still considered as very obscure in the *history* of the *earth*, I restricted myself to

the description of the phenomena wherein may be traced the *history* of our present *continents*, now dry, though manifestly heretofore the *bed* of the *sea;* and I think that even then I rendered sufficiently evident some propositions, which have been confirmed by all my subsequent researches, and in which I have met with the acquiescence of M. M. de Saussure and DE DOLOMIEU, who indeed have supported them by their own observations.—1. That the retreat of the *sea* from our *continents* was not occasioned by any kind of *slow cause*, as most geologists had hitherto supposed, but by some *sudden revolution.*—2. That since this last revolution took place, there has been no *change* in the *level* of the *sea.*—3. That, by the *progress* of the effects of all the genera and species of operations of those causes which have acted on the *continents* since their birth, it visibly appears that no very *remote era* can be assigned to that event.

10. Such was the point at which I had arrived in my *Lettres sur l'Histoire de la Terre & de l'Homme;* but M. de Saussure soon carried Geology much beyond it: he threw light, even in his 1st Volume, on the *origin* of the substance composing the observable mass of our *continents;* having conceived the idea that they had been originally contained in a *liquid* which at first covered the whole globe, and from which they were successively detached by *chemical precipitations.* This idea struck me, as certainly leading to truth; but much study was required to follow it to a sufficient depth; to that

study I devoted myself; and, as I have stated in my subsequent writings, it left in my mind no doubt respecting this object. But here again, when M. de Saussure announced this idea in his first Volume, he accompanied it with another, which was only accessory to it, and which I could by no means admit. Having observed that, among the substances evidently disposed in *parallel strata*, some were very much *inclined*, and even almost *vertical*, a circumstance not corresponding with the idea of *precipitations* at the bottom of a *liquid*, he explains this phenomenon, § 340, in the following manner. " Almost all the *strata perpendicular* to the horizon, " which are found in the *Jura*, have their directions " from the N.N.E. to the S.S.W. according to the " general direction of that chain of mountains. " For a long while, I supposed that all these *strata* " must have been formed in a situation either " *horizontal*, or but *little inclined;* and that such " as were found *vertical*, or *strongly inclined*, " had been brought into that state by some revolu-" tion: but having repeatedly met with *strata* thus " situated, having seen them in mountains very well " preserved which do not appear to have suffered " any subversion, and having observed great re-" gularity in the form and direction of these *strata*, " I am hence led at last to believe it possible that " beds of this kind, *strongly inclined*, and even " *perpendicular* to the surface of the earth, may " also have been formed by Nature."

11. When I conceived the design of a new excursion to the mountains of *Neufchatel*, it was not only for the purpose of verifying my own recollection of the *blocks* of *granite* which, contrary to the idea of M. de Saussure, abounded on the side farthest from the *Alps;* but the passage just cited supplied me with another motive. I knew that the above nearly *perpendicular strata* in the *Jura* contained *marine bodies*, and must therefore have been formed in a situation not very far from *horizontal;* from this circumstance which I had likewise observed in other places, I had concluded that all these *strata* had undergone great *catastrophes;* and it was important to observe and describe their state in the very places of which M. de Saussure had spoken.

12. At the time of my journey, therefore, to the mountains of *Neufchatel*, I had both these objects in view; but the discussion of the latter will not be necessary in the account which, after so long a period, I shall now give of that excursion. For in 1786, four years after I had made it, M. de Saussure published his 2d Volume, wherein he not only abandoned the idea that *struta* containing *marine bodies* could possibly have been formed originally in a *vertical* situation, but he extended to the *schisti*, the *granites*, and other substances of those genera, the catastrophes which I had ascribed only to the *secondary strata*, containing *organized bodies*. His demonstrations of this hypothesis ap-

peared to me like a ray of light dispersing the mist wherein the *Alps*, and all the other mountains which I had observed of the same class, had hitherto been enveloped: I clearly recollected all the situations described by M. de Saussure; and I felt like a man who should suddenly acquire the knowledge of a language in which he had been taught to speak a few words, without understanding their meaning. Hence I was induced to undertake successive journeys to mountains of that class, for the purpose of observing them with my eyes thus opened; and on this account I delayed the publication of my journey in the *Jura*. But as the above hypothesis is the foundation of the system contained in my subsequent works, and especially in my *Elementary Treatise on Geology*, before I adduce the proofs of it which these Travels will be found to contain, I shall here repeat its origin in the words of M. de Saussure.

13. A fortunate position taken by that geologist determined his ideas on the construction of the chain of the *Alps*, respecting which he had already formed a conjecture in the *Valorsine*, as I shall hereafter mention. This position was on the summit of the *Cramont*, an insulated mountain, rising 8,400 French feet above the level of the sea, in the most favourable situation possible for viewing the profile of all the transverse intersections of the chain, from the line of *Mont Blanc* in its central part, to its confines in the high *calcareous mountains* which

border the exterior openings of its great *vallies.* In following these vallies, he had successively described the nature of all the ridges of mountains intersected by them, and preserving a kind of parallelism with the granitic chain; of which *ridges*, as viewed from the *Cramont*, he then speaks in the following manner, § § 916 & seq. " The most re-" markable circumstances in the *Cramont*, and the " neighbouring mountains, is the situation of their " *strata*, which all rise towards the primitive chain. " This situation is particularly striking, when we " view from the S.W. the summits belonging to the " chain of the *Cramont* and the lower chains on " the side next *Mont Blanc:* these summits, which " terminate in sharp pyramids, lean towards *Mont* " *Blanc*, and are cut down abruptly on the " side next that mountain, where many of them " even overhang their base; their number is so " great, and their situation, I might say indeed their " attitude, is so uniform, that, in parts where there " are many of them one behind another, they " might almost be taken for animated beings, ready " to spring towards *Mont Blanc*, or at least press-" ing forward to view it . . . . . From the chain " to which the *Cramont* belongs, to that imme-" diately commanding the *Allée Blanche*, I counted " six parallel rows of these summits, all consisting " of numerous *strata* disposed in a situation exactly " similar. I measured the inclination of several " of the pyramids, and found that their *strata* " formed angles of about 50°. with the horizon.

"These chains are intersected on the N.E. by the "valley of *Courmayeur;* but notwithstanding this "interruption, the mountains situated beyond that "valley, on the same line with the *Cramont,* con-"tinue to rise against the *central chain,* and to "have their abrupt sides turned towards it; their "disposition to preserve this inclination is even so "strong, that, where the direction of the *chain* is "changed, that of the *secondary mountains* turns "also, and their *strata* are every where seen erected "against it."

14. Before I proceed to the conclusion which M. de Saussure deduces from this great scene, I must insert what he says of the *pudding-stones* (or rather *breccias*) of the *Valorsine;* as from them he first understood that the *strata,* now found strongly *inclined,* and sometimes even *vertical,* must nevertheless have been formed in a situation nearly *horizontal;* this being the foundation of his conclusion, which I shall afterwards quote. He first met with some masses of these *pudding-stones* at the foot of the mountain, where I had myself seen them with surprise, when I had been on that spot with my brother. He then continues thus, §§ 689 & seq. "I "was curious to see these *pudding-stones* in their "original place; I ascended strait to the top in "order to discover it; but what was my astonish-"ment at there finding their *strata* in a *verticle* "position! The reason of this astonishment will "easily be understood by those who consider how

" impossible it is that these *pudding-stones* could " have been formed in such a position. We may " easily conceive that particles of extreme tenuity, " suspended in a liquid, might agglutinate together, " and form *vertical strata*; . . . . but that a stone " already formed, of the size of a man's head, " should remain at a certain height against a *vertical* " wall, till small stony particles should collect them- " selves around it, cement, and fix it in its place, " is a supposition utterly absurd and incredible. " We must therefore consider it as a point demon- " strated, that these *pudding-stones* were formed in " a *horizontal* situation, or nearly so, and that " afterwards, when indurated, they assumed this " erect position. . . . . The very nature of the sub- " stance in which the pebbles of these *pudding-* " *stones* are imbedded renders this fact more curious " and more decisive; it is a *schistus*, of which the " elementary laminæ are extremely thin, inter- " spersed with *mica*, and perfectly parallel to the " planes which divide the *strata* of the stone. " These *strata* are themselves very regular, varying " from half an inch to several feet in thickness; the " thinnest contain few or none of these extraneous " pebbles; and I observed some alternations of " the same *strata* entirely without them. The " colour of this *schistus* differs extremely; in some " places it is grey, in others greenish, but for the " most part it is purple or reddish; sometimes also " it is variegated with all these colours. . . . . The " pebbles imbedded in it are of different sizes, from

" that of a grain of sand, to 6 or 7 inches in dia-
" meter; they all belong to the class of the *rocks*
" called *primitive* . . . . . The bed of these schistose
" *pudding-stones* occupies, in the mountain, a thick-
" ness of about 100 fathom, reckoned from west to
" east, transversely to the *strata;* I have followed
" it lengthwise for about a league; it cannot be
" traced any farther, because it disappears under
" the earth."

15. After having thus perceived, from these *strata* of *breccia*, that all the *strata* now *vertical* between which they are placed must also have been formed in a situation nearly *horizontal*, and having evidently shewn, by his observations from the *Cramont*, that all the ridges of mountains separated by intersections, together with their summits, of which he gave very exact descriptions, were masses of *strata* strongly *inclined*, presenting their *section* at the top, M. de Saussure could very well discern in the *strata* themselves, when he had a near view of them, characters distinguishing the *lines* of their separations, from the *fissures* that intersected and disordered them; by the want of which distinction many naturalists, and myself among the rest, had been hitherto prevented from understanding any thing in these mountains. If, for example, the crystals in *granite* differ on the opposite sides of a *line*, while those on each respective side are all alike, or if there is common *granite* on one side, and *gneiss* on the other, that *line*, and all those which are parallel with it, whatever may be their

situation, indicate separations of the *strata*. If the stone is regularly *veined*, as being composed of laminæ of different colours or substances, the *lines* parallel with these *veins* indicate also divisions of the *strata*. If the mass contains *extended bodies*, such as long crystals of *feldspar*, and lines of *mica*, or extraneous substances, such as the stones in *breccias*, and *marine bodies*, the *lines* parallel with their *direction* are again *divisions* of *strata*. But there are other circumstances which likewise demand attention; for instance, we must not expect to be able always to have many *strata* at once within our view; for in the *calcareous* mountains containing *marine bodies*, as well as in those of *granite* and other primordial stones, and likewise of *sandstone*, there are some *strata* of not less than 60 feet in thickness. The substance of some of the *schisti* has a tendency to break in certain determinate forms, even in angular lines like those of fortifications; so that, when a mass has been thrown considerably out of its place, it is at some distance only that the *strata* can be distinguished in the large fragments, or in the intersections of the summits. Lastly, in every class of *strata*, there are sometimes masses so much fractured in all directions, that the lines of their separation cannot be distinguished any otherwise than as being those along which they may be divided without effort, and with smooth surfaces on both sides. From not having attended to all these circumstance, many geologists, and especially the partizans of the *Huttonian theory*, have denied the *stratification* of *granite*, and other substances of the same class, considering them as the products of *fusion;* but this is an error, as may already have been seen in my Travels in *England*, and will again appear in these.

16. I come now to what M. de Saussure says of the first ideas suggested to him by the state of the mountains when he viewed them from the *Cramont*, having before his eyes the grand scene of which I have already cited his description, from the central chains of the *Alps* composed of *primordial strata*, to the *calcareous* chains on the outer side; it is in the following manner that he expresses these ideas, § 919. "From these conformities I concluded, that, "since the *secondary mountains* were formed under "the waters, the *primitive* must have had the same "origin. Revolving afterwards in my mind the "succession of great revolutions which our globe "has undergone, I viewed in imagination the *sea*, "covering, as it heretofore did, the whole surface "of the earth, and producing, by its deposites and "by successive crystallizations, first the *primitive* "*mountains*, then the *secondary*; I beheld these "substances arrange themselves *horizontally* in "concentric *strata*, the shell thus formed being "subsequently *raised up* and *broken* by fire or other "elastic fluids enclosed within the globe, in such a "manner as to bring to view externally its lower "and *primitive* part, and to leave its exterior and "*secondary* parts supported by the inferior *strata*.

"After this, I beheld *abysses* burst open and left "vacant by the explosion of the elastic fluids, the "waters, as they rushed towards these abysses, "carrying along with them to great distances those "enormous *blocks* which we find scattered on our "plains . . . . . Such were the thoughts suggested to "me by these new observations in 1774: it will "be seen in my *4th* Vol. how far twelve or thir"teen years of continual observations and reflex"ions on the same object may have modified this first "germ of my conjectures: here I am speaking of them "only historically, and for the purpose of shewing "what are the first ideas which this grand prospect "from the *Cramont* must naturally suggest to a "mind not yet occupied with any system."

17. Nobody has regretted more sincerely than myself the premature death of this great observer, not in Geology alone, but also in Meteorology. The sufferings that attended the latter years of his life were the cause that this *4th* Volume, for which I had waited with great impatience, appeared without containing the theory again announced in the *3d*, while, at the same time, he continued to multiply hypotheses unconnected with any determined theory; so that I have not been much surprised at hearing since, from persons who were intimate with him, that the longer he considered this subject, the more uncertain he became. To these great ideas, first conceived by himself, he added others, to which he was too strongly attached, and which led him into a

kind of labyrinth; particularly by diverting his attention from the examination of that great question, whether, in those catastrophes of the *strata* the reality of which he had so fully demonstrated, the parts now *highest* had been *elevated*, or the *lowest* had *subsided.* With respect to myself, I was forcibly impressed by his great discoveries concerning geological phenomena, clearly recollecting the objects which he described; and having followed the same course of observations in many other mountains, I have every where met with evident proofs that these catastrophes of the *strata* must have been produced by the *sinking down* of the parts now *lowest* into *caverns* which originally existed beneath them.

18. M. de Saussure, having neglected to seek for such phenomena as might have determined his opinion on the above question, did not attend to one great object, namely, that of the *mountains* themselves, the production of which, however, was implied in his discovery. Although he had perceived, and so clearly proved, that the *primordial* as well as the *secondary strata* were formed on the bottom of the *sea* in a situation nearly *horizontal*, and that if we now find them *broken* and inclined, it is in consequence of a great catastrophe, he nevertheless continued to apply to *mountains* the terms of *primitive* and *secondary;* while it is evident, from his own demonstrations, that our globe does not exhibit as *primitive* either *mountain* or *hill:*

nothing on it can properly be distinguished as *primordial*, (I exclude the word primitive.) except those *strata* which were formed antecedently to the existence of *organized bodies*; for, from the time that these bodies began to exist, especially in the *sea*, their exuviæ were involved in the *strata* subsequently formed, which were consequently the *secondary*; and both these and the *primordial* were subjected to the effects of the catastrophes, whereby were prepared for our continents their present *elevations* and *depressions*; that is to say, *mountains* and *hills*, *vallies* and *plains*. . . . .

19. At the first glance, it might seem merely an error of expression to apply to *mountains* the terms of *primitive* and *secondary*; but the idea of *mountains* thus distinguishable was actually present to the mind of M. de Saussure himself; and it was this idea which led him into the hypotheses that afterwards embarrassed him. Hence, in the first place, he was induced to attribute such great effects to what he called the *débacle*, that is to say, the *retreat* of the *sea* from the *strata* formed on its bosom by *chemical precipitations*: to the motion of the water at that epoch he ascribes the *excavation* of the *vallies*, through which he supposes this *current* to have transported immense masses of stones belonging to the central chain of the *Alps* beyond the precincts of those mountains, and to have scattered them over the *Jura*; whereas the catastrophes, of which he has demonstrated the existence and pointed

out

which the catastrophes of the *strata* could have been effected was by the *subsidence* of the parts at present the lowest. This subsidence, as it could not have taken place any otherwise than by means of *caverns* previously existing beneath the *strata*, afforded me an explanation of the quantity of masses of *stone* dispersed over vast tracts of country consisting of plains and hills of pure *sand*, far remote from all mountains in which are found any rocks of stone of the same kinds. Now after I became sensible of the justness of M. de Saussure's conclufion, that no distinction was to be made between the *primordial* and the *secondary strata*, with respect either to the mode of their *formation*, or to their original *situation*, I had a much clearer comprehension of the *plains* and *hills*, as well as of the *stones* which are scattered over them: for since, in various countries, we find, in these lower grounds, the same *primordial strata* as in *mountains*, intermixed with *strata* of *lime-stone* and of *sand-stone*, it is evident that the *caverns* must have extended under all these spaces, and that the *air* pent up within them, by its violent compression in consequence of the descent of such immense masses of the fractured and broken strata, must have thrown out fragments of those masses in great abundance. That the above is an adequate explanation, and that the phenomenon itself will not admit of any other, has been shewn, by very exact descriptions, in my *Travels* lately published, along *some parts of the coasts of the Baltic and of the North Sea;* and this conclusion will be confirmed by the Travels of which, though they were in date anterior to the others, I have deferred till now, for reasons formerly explained, to give an account.

22. It was in 1782 that I made this excursion into that part of the *Jura* which belongs to the *countries of Neufchatel and Valangin*, having in view the two objects stated above; namely, the *situation* of the *blocks* of *granite* in these mountains, and the circumstances which prove that their *strata* were not formed in the much *inclined* or nearly *vertical* position wherein we at present find them. But M. de Saussure having changed his opinion on the latter point, I shall only describe these *strata*, and attend more particularly to the *situations* of the *blocks*, that I may shew the utter impossibility of their having been transported to these mountains from the *Alps:* my other remarks will be of a more general nature. I formed the plan of this journey at *Paris*, where it was suggested to me chiefly by the intimacy which I had contracted with M. GUYOT, who was a native of these mountains, and had observed them with an attentive eye: he had measured barometrically the heights of many places situated in them, above the level of the lake of *Neufchatel;* and he was desirous that many of their phenomena, which he had viewed with surprize himself, should become the object of my particular examination. When I had resolved on undertaking the journey, he gave me a very exact map of the country, marking in it

several of the roads which he wished me to follow, and furniſhing me with recommendations to those of his friends who lay in the way. Having the satisfaction to find him again at *Paris* on my return, I shewed him the journal of my observations, that I might be sure of the correctness of all my descriptions; and when I had communicated to him my remarks on the whole scenery of these mountains, especially the phenomena to which he had particularly directed my attention, he not only agreed to their exactness, but confirmed them by such additional facts as I had not had an opportunity of observing. I had the misfortune to lose this most valuable friend a few years afterwards, when he was deeply regretted, not only on account of his general knowledge, but of his many and distinguished virtues, by all who had known him as intimately as I had done.

Travels amongst the Mountains of NEUFCHATEL *and of* VALANGIN, *which form a Part of the Chain of the Jura.*

23. IT was about the end of April, 1782, when I set out from *Paris;* but I did not begin any regular observations till I approached the *Jura* by *Franche-Comté,* where, as this is the side of the chain which is farthest from the *Alps*, M. de Saussure had not supposed that any *blocks* belonging to the *strata* of the latter mountains were to be found.

May 1st, 1782—I had already observed a great many *blocks* of *primordial stones* before I arrived at *Ornant;* and as I ascended the mountain between that place and *Pontarlier*, I saw the road gravelled with fragments of *lime-stone*, mingled with others of *gneiss*, which had been broken from *blocks* taken up out of the fields. *Grange d'Alaine*, the stage between *Ornant* and *Pontarlier*, though at a high level, is situated in a vale, where I observed large *blocks* of *gneiss*. The whole *Franche Comté* is intersected with hills of *lime-stone*, the *strata* of which are of the same very distinct species that is found on the *summits* of the *Jura:* this circumstance was also remarked by M. de Saussure; and it shews, in concurrence with all the others which will be mentioned in the sequel, that the mountains of the *Jura* are now *eminences*, only because, on both sides of this chain, the strata *subsided* into caverns in the greatest disorder.

May 2d. The entrance of the *Jura*, in the way towards the country of *Neufchatel*, agrees in its *geological* characters with many similar openings into the interior parts of the chain, along the same side of it, as far as *Grenoble;* such, for example, as the pass which leads to the *Grande Chartreuse.* In approaching this chain, it was natural to expect to find an ascent by some road traced up the slope; but, on arriving at its foot, I discovered a cleft, affording entrance into a large interior space, which forms a kind of amphitheatre encompassed by mountains, and from the bottom of which rises a large rock, whereon is built the *Castle of Joux:* (*Joux* is a Celtic word signifying *forest.*) It is impossible not to perceive that this space has been produced by a great partial *subsidence* of the *strata;* for the *mountains* which encircle it, and of which the summits have many intersections, present towards it abrupt sides, whence project many rocks; and these rocks exhibit their *strata* in various situations, with different *inclinations* in the different masses, in some of which they have even their *section* at the top; the rock, especially whereon the Castle stands, is evidently seen to be a mass left at a higher level than the rest, when the whole sunk into the *cavern* beneath; for the *strata* of this rock are very nearly *vertical*.

24. Phenomena of this kind in mountains, composed of such *strata* as contain *marine bodies*, are certain guides in the determination of the nature of the catastrophes to which is to be ascribed the existence of *mountains* above the level of *vallies* and of *plains*: for as no doubt can arise with respect to the situation of such *strata* at the time of their formation, their present position affords us a kind of description of the catastrophes which they have undergone; and when the same characters are found in the mountains composed of *primordial strata*, (as I shall shew to be the case in some of my subsequent travels,) it will evidently result that the latter must likewise have been subjected to the same catastrophes. But before I continue my description of the interesting spot of which I have begun to speak, I must remind my readers of the meaning of a word that I have used in the volumes already published of my Travels; because in these also, I shall have frequent occasion to employ it.

25. The terms *valley* and *vale* are understood in general to imply intervals dividing neighbouring emi-

nences from each other; but there are some intervals of a particular form, which, in the *Jura* and the *Alps*, and likewise in chains of hills in *England*, are distinguished by the name of *combes*, a word of Celtic origin; and as this distinction is very important, and even necessary, I have adopted it in my descriptions of similar grounds in all countries. *Vallies* and *vales* are intervals of considerable length, which either lie between ridges of eminences, or intersect them; in these flow *rivers*, or smaller permanent streams, formed by the assemblage of the waters of all the springs belonging to a tract of country more or less extensive, and serving, at the same time, as channels for the rain-waters which fall within that space. It is by the permanence of the *streams* flowing in these beds that superficial observers have been led to suppose the *waters* to have *excavated* their own *channels*. But in *combes* this illusion ceases; for although, in some part of their extent these latter intervals are sometimes exactly similar to the former, exhibiting the same depth, the same abrupt sides, and the same projecting rocks, yet no river either passes through them, or ever can have passed; for they terminate on the heights; no waters therefore flow in them, except those which ooze out on their sides from the intervals of the broken *strata*, and those of the rains immediately falling in them. Now the road leading from the interior amphitheatre above described, to the top of the mountain, passes up a *combe*, in the sides of which will be seen all the characters common in those of *vallies*, though its formation cannot possibly be ascribed to the action of any *stream.*

26. In the upper part of the sides of this *combe*, which, for a considerable way, are very high, appear the *sections* of *strata* in great disorder; and here I observed one of the *chronometers* so frequent among mountains. These sides, originally abrupt to a great height, crumble down from the different actions of the air, and especially from frosts when their crevices are filled with water: their fallen materials accumulate against them, and rise in the form of a *talus*, or slope, on the surface of which vegetation cannot establish itself in the parts where fresh materials are continuing to fall in great abundance; in other parts, these slopes are covered with plants; trees grow on them wherever the masses which compose them are of a large ſize; the rest of their surface produces merely grass. But when I ascended this *combe*, I found that in many parts its sides were overspread with vegetation only at the bottom, or a little way up; the plants springing up on them being buried by the rubbish which still fell from above. Would not this operation be terminated every where, as it actually is in many places, if our continents had existed from a very remote antiquity?

27. In this *combe* is the village called *Les Verrières de Joux*, which according to M. Guyot's baro-

metrical measurements, lies 1440 French feet above the level of the *Lake of Neufchatel*, the latter, according to my own measurement, being 1300 feet higher than the *Mediterranean:* in speaking of the heights of places in these mountains, I shall not think it necessary to repeat either this last elevation, or the kind of feet by which I reckon. This is the side of the *Jura* that is farthest from the chain of the *Alps;* and the road to the *Val de Travers,* on the opposite side fronting that chain, lies across a ridge of eminences, which forms the line of division of the waters of the *Jura,* throughout the whole length of these mountains: all the streams descending the western slopes proceed in a southerly direction to the *Mediterranean,* uniting their course with that of the *Rhone;* this is likewise the case with such of those on the eastern side as enter the *Lake of Geneva;* the rest of the streams on the latter side, and especially on this part of it, enter the *Lake of Neufchatel,* whence they flow, with the *Rhine,* to the *North Sea.* Not far from the point where I crossed this chain is *Mont Chasseron,* the highest of its eminences, 3560 feet above the *Lake of Neufchatel;* and a narrow cleft through which I passed at the top of the *combe* is 2330 feet above that *lake,* and consequently 890 feet higher than *Les Verrières de Joux.* Here then we find, on the side next the *Alps,* a strong barrier, the nature of which will presently appear; yet I observed a great number of very large *granitic blocks* in the village, and some way above it.

28. When I had passed through the narrow cleft by which I crossed this ridge of mountains after ascending the *combe*, a very striking scene presented itself to my view: I here found myself on the brow of a precipice, at the bottom of which I beheld the village of *St. Sulpi*, situated in the highest part of the *Val de Travers*, but only at the elevation of 1150 feet; consequently 1180 feet below the cleft from which I looked down upon it. The immediate descent of this precipice being impracticable, a road has been cut along a promontory dividing the upper part of the *Val de Travers* into two branches. This is another interior amphitheatre, which cannot possibly have been produced any otherwise than by a greater *subsidence* of the *strata;* it is on all sides encompassed by their abrupt sections, wherein their positions bear witness to that catastrophe: on the side of the promontory along which the road down to it has been made, they are seen to *incline* more and more, till at last they become nearly *vertical;* and in front of the extremity of this promontory rises an insulated mount, similar to that on which stands the *Château de Joux*, as well in its form, as in the position of its *strata.*

29. It was in this last mentioned amphitheatre that I remarked the first phenomenon of the waters; whence it appears that the catastrophes of the *strata* have produced the same effects within the *mountains*, as may be observed externally. The *Reuse*, a small river which flows in the *Val de Travers*, issues from

the foot of the rocks bordering this space, in a place where the *strata* are almost *vertical;* and is, even at its origin, of a sufficient size to turn some wheels. It will be seen in the sequel that this *river* receives no increase except from brooks of a similar nature, which burst forth on both sides all along this *valley;* and in my various excursions among these mountains will also appear what remarkable phenomena are connected with the waters which flow within them, and afterwards issue forth in the vallies.

30. I had been advised by M. Guyot to chuse *Couvet,* a village in the *Val de Travers,* as the first central point of my observations in these mountains; and he had recommended me there to his friend Captain STEINER, from whom I received all the directions and assistance for which I had occasion. I spent three days at *Couvet* without being able to undertake any long excursion, because it rained or snowed almost without intermission; and even on the 6th of *May,* when I at last determined to take advantage of an interval between the showers, they did not allow me time to go very far.

31. In that part of the *Val de Travers* where its slope is pretty regular, are situated, down the course of the *Reuse,* the villages of *St. Sulpi, Fleurier, Boveresse, Mortier-Travers, Couvet,* and *Travers:* it is bordered by hills composed of *strata* of *limestone,* forming a kind of *terraces,* with some interruptions and projections, along the foot of the highest

ridge of the *mountains* which they conceal from the view of the traveller on the side of the valley where he happens to pass. In these lower eminences, there is, near *Couvet*, a great intersection, by which I this day ascended. As I proceeded, I found the left side of this intersection, within a certain extent, to be cut down abruptly; the opposite side presenting only a slope consisting of *calcareous* fragments, intermixed from top to bottom, and across its whole breadth, with *blocks* and smaller fragments of *granite*, *gneiss*, *quartz*, and several other kinds of *primordial stones*. This is a very remarkable phenomenon, which I shall frequently have occasion to point out. It is not, on the *slopes* of *rubbish*, under *rocks*, that *primordial stones* are found; it is only among the fragments of *lime-stone*, which, at the birth of the continent, already existed on its surface, even at a distance from any higher rocks, and which consequently can only be considered as one of the effects of the catastrophe whereby the *vallies* were produced.

May 8*th*. I had again, on the 7th, been confined within doors by the rain; but this day I crossed the *Reuse* at *Couvet*, intending to examine the nearest part of the *mountains* on its right bank; and my first observation will afford an example of the case which I have just mentioned. I began by ascending a slope leading up to some low cultivated hills; and on this slope I found fragments of *lime-stone* mixed with others of *primordial* kind. Beyond the cultivated part I came to woods, growing on a *talus* of the *rubbish* falling down from rocks above. I followed the lower border of these woods, expecting to find some path; but there was only a very steep one, by which, when the trees are felled, they are brought down in winter on the snow. By this steep path, however, I ascended to the foot of the rocks, where I found nothing but their own rubbish, unmixed with any *primordial stones.* I had much difficulty in climbing up the rocks themselves, above which I came to a large space, partly cultivated, and partly covered with grass, extending towards summits cloathed with wood. In clearing this ground for tillage, the stones taken out of the fields had been laid up in heaps, where I again observed the same mixture of fragments of *primordial stones* and *lime-stone;* but this *lime-stone* was not similar to that of the rocks; it was harder, and had a finer grain. I found in it some impressions of *cornua Ammonis*, and one *echinite.* No cause, which has been in action since the continent has existed, can produce such a mixture of fragments on the *summit* of a mountain.

32. Proceeding along this summit towards the part immediately above *Motier-Travers,* I came to a farm called *Pierrenoud*, with which many recollections were associated in my mind: I had been there about fifteen years before with J. J. ROUSSEAU, who at that time was living at *Motier-Travers;* Madame BOIS DE LA TOUR, to whom this farm belonged, had fitted up for him in it a small apartment,

where he spent part of the summer in botanical pursuits; and I was then already engaged in observing all this part of the mountains, from the *Val de Travers*, to the opposite extremity of the *Lake of Neufchatel*, which lies at their foot.

33. The projection, or *terrace*, which borders this part of the mountain above *Motier-Travers*, is very remarkable: it is so high, that, from a very small distance, it might be taken for the mountain itself, to which, however, it is united only at one of its extremities, being separated thence, except at that point, by a wide fracture; and in this interval, forming a small *combe*, the road has been made which leads up from the valley to the mountain. In the upper part of the mountain appear also visible marks of the catastrophe whereby the *valley* was produced; for, as I descended from *Pierrenoud* towards this *combe*, I came to another *intersection* of the *strata;* forming a kind of small vale covered with grass; in which the waters of the springs above are collected, and led to fall in a cascade from the abrupt brow of the mountain, near the upper part of the *combe*.

34. When I had reached this point in my descent, I saw on the slopes, on both sides of the *combe*, a great many blocks of granite; my attention, in particular, was engaged by three of these which lay on the higher part of the slope of the hill forming the

detached terrace. I went down to the bottom of the *combe*, and thence ascended to the spot where these blocks lay; one of them was from 18 to 20 feet, and the others seven or eight feet, in their greatest length, in which direction they were lying: otherwise, the slope being so rapid, they must have rolled down to the bottom: they were buried in rubbish, to the depth of two or three feet, as far as I could judge, the rubbish being covered with grass. My servant, who accompanied me in these excursions, and who, beholding objects of this nature for the first time, must have been incapable of feeling surprize, if every thing around him had not now excited it, expressed great astonishment at seeing these masses in such a situation. His attention was first attracted by the brilliancy of their crystals in the sunshine; and having remarked that the rocks of the mountain exhibited nothing similar to this, he asked me whence these stones came? I told him that I did not wonder at his question, since men much better informed than he was had been puzzled by such stones. He remained silent for a few moments, looking sometimes up to the top of the mountain, to consider again the rocks, and sometimes down to the *combe*, of which, from the point where we were standing, we could not perceive the opening; and he then suddenly exclaimed, "Sir, they must certainly have come out of the inside of the mountain by this deep hole;" (meaning the *combe*;) "for they cannot have fallen from the sky." I do not believe that any person, on visiting this spot, and considering all the circumstances, could form a different judgment.

35. I went up to the summit of the hill, and found it covered with grass, above which, here and there, rose sections of the *strata*, dipping towards the *combe*, and consequently towards the body of the mountain: the surface was every where scattered with fragments of *primordial stones* differing in size; on the opposite slope above *Motier-Travers*, I saw a great *block*, to which I went down, and found it equal in bulk to the largest of those described above; nor was its position less remarkable, as will presently appear. I perceived that this slope terminated suddenly in a more rapid declivity; and having descended to that point, I found myself on the brow of a naked precipice, studded with rocks, and not appearing to extend so low as to the bottom of the valley: I then walked round the summit till I came again to the *combe*; and having descended by it into the valley, I saw, as I went farther from the mountain, that the lower part of the precipice was covered with a large talus of its own rubbish. I then re-ascended the *combe*, in order more particularly to examine the point of connexion between the hill and the mountain, where I found new marks of a catastrophe. An insulated mount, on which are the ruins of an ancient castle, has here been detached from the terrace by a *subsidence*; and I descended towards it, that I might observe it more nearly: the planes of its *strata* are turned likewise towards the mountain;

and on the side next the terrace, they are seen, in their lateral section, not to differ more than 25° or 30° from the *vertical.* These *strata* also, in their descent from the level at which those of the mountain remain, have all undergone various fractures; so that, in different masses, they dip in opposite directions; some masses have even been thrown in such a manner, as that their summits lean against each other; and the vacancies left between them below are filled with rubbish.

36. This external disorder of the *strata* is accompanied with equal disorder in the interior part of the mountain; and the latter leads to a determination of the true cause of the former; for none of the causes imagined for this purpose could have acted within the mountain. Near the *cascade* already mentioned, a small stream, called the *Bied,* gushes out from the foot of the rocks; and at *Motier-Travers* it joins the *Reuse,* before described as issuing forth in a similar manner near *St. Sulpi.* I remember that, above this place, Rousseau had pointed out to me the entrance of a *cavern,* the inside of which I was desirous to see. With this view, in my return from the mountain, I went to call on M. Perrin, the clergyman of *Motier-Travers,* to whom my friend Guyot had given me a letter of recommendation; this gentleman expressing great readiness to oblige me, I consulted him with respect to my visit to the *cavern,* whither he offered to accompany me the next day; and having arranged our plan, I took my leave of him, and returned to *Couvet.*

37. In the way, I passed several large *blocks* of *granite;* and some persons who were going by, and saw me observing them, informed me that a great number had been removed for the purpose of making mill-stones. This part of the valley has very little slope; and the waters, which have levelled it during floods, have deposited so much sand between the large stones, that few now appear in the meadows covering its bottom; but the *Reuse* has not suffered any of this sand to remain in the usual channel of its stream, on which *blocks* of *granite*, and other stones of the same class, lie in such great abundance, that I could have fancied myself in the *Alps;* nor can these *blocks* be liable to impulsion by the stream, for they are covered with *moss.*

May 9th. I went from *Couvet* to *Motier-Travers*, where M. Perrin had been so good as to make every preparation for our visit to the *cavern:* the guide usually employed was gone before, in order to lay planks over a pool of water, which is formed, whenever the springs are full, a little within the entrance; he was also to place a ladder for our ascent thither, and to prepare lights: I have already said that this entrance is near a *cascade* formed by the superficial springs of the mountain, which precipitate themselves from the top of an abrupt section of the rocks.

38. From the appearance of the spot, it is not at all surprizing that a *cavern* should be found here: the broken *strata* have fallen in large masses, one

over another; and the entrance of the *cavern*, to which it is necessary to ascend with a ladder, is formed by a vacancy remaining between two of these masses. At first, the passage is narrow; but it soon grows wider, and opens into a vast cavity produced by the *subsidence* of all the lower *strata* beneath the uppermost stratum which forms the roof; the sunken parts here have been so much shattered, that our advance was impeded by large masses of their fragments; however we continued to ascend till we reached the end of this first space, where we came to a wide fracture, prolonged a considerable way into the interior part of the mountain. In the roof of this winding passage, wherever it is not covered with soft *stalactite*, or *tofus*, the *strata* are seen to descend towards the mass of the mountain, forming an angle of 30° with the *vertical*.

39. The *strata* are intersected by several other large fractures, at the entrance of one of which we heard a low noise, like that of a stream; we entered it, preceded by the guide, and went down towards the part whence the sound proceeded. Our descent was over blocks covered with *tofus*; and it brought us to a space some feet in diameter, crossed by a stream of water, which, at the same time, we heard murmuring within the mountain: this stream is supposed to be the *Bied*, already mentioned as issuing forth at the foot of the rocks. We proceeded as far beyond this point as we found it practicable, walking all the way on masses covered with *tofus*. It may

be judged that there are here some crevices which go down to a great depth; for the water that drops from every part of the roof and the sides of these *caverns* does not lie on their bottom. The *tofus* is continually increasing in these spaces, where it forms grotesque masses, and lines the sides of the large *crevices*, which it thus contracts, and tends finally to close. The guide told us that it is known to have been practicable to proceed from this cavern to the village of *Travers*, at a league's distance, by a fissure of which he shewed us the continuation in the roof, till its entrance was closed up by the mass of *tofus* now risen before it; that whether the passage was still open within could not be known any otherwise than by cutting through this mass; but that nobody was sufficiently interested about it to take the trouble.

40. This affords a first example of the internal state of these mountains, and hence it results that those *subsidences* of the *strata*, during which *mountains* and *hills* were formed by the masses remaining at a higher level, must have been attended with other *subsidences* within these masses themselves, intersected throughout with fractures; between which, in some places where the upper parts found support on the sides, those beneath them sunk down to a greater depth, leaving in the intervals the spaces which are called *caverns*. Of this circumstance, the same mountains will exhibit more striking effects.

41. The *progress* of the *tofus* in this *cavern* is also a remarkable example of one of the *chronometers* which I mentioned in my *Lettres sur l'Histoire de la Terre et de l'Homme,* though there I described it only on the exterior parts of mountains; particularly the *calcareous* eminences of the *Alps,* and others in their neighbourhood, such as *Mont Salève.* At the origin of the continent, several brooks fell in *cascades* down the abrupt sides of those eminences, along which they deposited *tofus;* and this *tofus,* having accumulated, now forms long promontories advancing either into the plains, or across the vallies. It being there a point of interest to prevent the extravasation of the water which follows these promontories, and is continually enlarging them, canals have been cut along their summits; but if these canals are not cleared out from time to time, the *tofus* fills them up. It has been necessary also, in order to keep open the great roads through the vallies, to cut off the ends of some of these promontories, from which, where this has been done, the water again falls in a cascade; but the *tofus* soon accumulates again, and rises up on the road, if crossed by the stream; so that it frequently requires to be cut away. Now this is precisely the same *chronometer* which I have just described in the above *cavern;* and in the course of these travels I shall give similar instances in other *caverns,* wherein are formed harder *stalactites,* which also tend to obstruct passages formerly open. This is a circumstance that will be transmitted by successive generations to each other, like

the accumulation of *ice* in the high *vallies* of the *Alps*, by which likewise passages frequented within known times have been obstructed.

May 10*th.* There being still a continuance of rains and snow-storms with a very cold east wind, I could not yet undertake any long excursions, but could only take advantage of the intervals which appeared most favourable, not venturing to too great a distance from places where I might take shelter, if I found occasion for it. My plan to-day was to ascend to the upper part of the *terrace* commanding *Couvet*, and to follow it till I should arrive immediately above the village of *Travers*, which is situated lower in the valley, and to which I meant to descend, in order to cross the *Reuse* in that part, and return along its right bank to *Couvet.*

42. At first setting out, I ascended by the intersection which I described § 31, to the border of the woods covering the highest part of the mountain; and following this line, I saw a quantity of *blocks* of *primordial stones* of various species, rising above the turf which covered the soil. I descried at a distance a large space without any grass on it the whole way from the valley up to the edge of the woods. I was surprized at this, because I did not see any rock above, the rubbish of which could still fall to impede the progress of vegetation. I went therefore towards this part of the slope, and found that it was entirely covered with a mixture of *calcareous* and

primordial stones. It was evidently impossible that this could be a *talus* formed by the descent of fresh rubbish; but as, with much difficulty, I walked up it, I discovered the cause of what had thus embarrassed me. The slope is here formed by a large mass, which those composing the *terrace* stopped in its descent towards the point of the great *subsidence* whence the valley resulted, and which presents on this side the plane of its *strata* very much inclined; and the difficulty of my ascent was occasioned by the loose stones scattered on this slope, which rolled under my feet at every step. For this reason, there is here no soil for vegetation; such minute fragments as are detached from the exterior stratum are washed down from it by the rains; and the heat produced by the sun in summer, when it strikes on these stones, burns up the few plants springing from the seeds which have happened to settle here.

43. I was obliged to go up into the woods, in order to cross a promontory which advances from the mountain as far as the brow of the terraces, and behind which I was to descend towards *Travers*. I found the soil of these woods intersected with projecting ledges of *strata*, having the same direction and the same degree of inclination as those of the uncovered mass just described; so that the *terrace* below the latter very evidently appears to be a mass similar to that which forms the promontory, though it has slidden down to a lower level,

from not meeting so soon with a support beneath. Among the firs on the promontory, and on the upper slope of the mountain, I observed some beeches, the roots of which had insinuated themselves between these *strata*, all much shattered, and nearly vertical. In these woods, there are great numbers of large *blocks* of *granite*; and having advanced to the extremity of the promontory, I there saw, on the brow of a very rapid *slope*, a *block* nearly 20 feet long and 10 or 12 broad, rising seven or eight feet above the soil in which it was buried. At this point, the slopes of the promontory are very rapid on both sides, and likewise in front.

44. It could certainly have been only from very erroneous reports, that M. de Saussure was led to assert, as has been seen above, that there were no *granitic blocks* in the county of *Neufchatel*; for had he seen such masses as these in the positions which I have just described, he could never have conceived the idea that they had been transported hither from the centre of the *Alps*; but, considering the ruinous aspect of these mountains around the low spaces, here so frequent, he would have paid more attention to the explanation which I had given of these phenomena before he published his 2d Volume; and he would have comprehended that, during the descent of enormous masses of the whole crust of the *strata*, including those of *granite* and other substances of the same class, into *caverns*, already filled with expansible fluids, it would have been

more easy for these fluids, when thus violently compressed, to have thrown out fragments detached by the collision of the masses, than to have raised up the central chain of the *Alps*, as supposed in his hypothesis.

45. While, from the extremity of this promontory, I was observing the neighbouring objects, the air became dark, and threatened a heavy rain. In order to descend from hence to *Travers*, I was obliged to go back towards the mountain, and to make a circuit round many of its intersections; so that the rain overtook me in the way. On reaching *Travers*, I hastened to take shelter at the house of M. GALLOT, the clergyman of the place, to whom I had been recommended by M. Guyot, and by whom I was most cordially received, as the friend of one who was his own friend: he offered to be my guide in two very interesting excursions, whenever the weather should permit; and this very day, when the rain was over, he was so good as to accompany me on my return to *Couvet*, along the right bank of the *Reuse*.

46. This part, likewise, of the *Val de Travers* bears the impression of the catastrophes by which it has been formed. After having crossed the *Reuse* at this village, we ascended very gradually through arable lands to the foot of the mountain, here also skirted by an irregular *terrace*, which cannot be cultivated, because it is every where intersected with

points of the dipping *calcareous strata*, intermixed with *blocks*, both of the *strata* themselves, and of *primordial stones;* so that its only product is the grass which springs up in the intervals of these masses. The foot of the mountains is covered with woods growing on *slopes* composed of the *rubbish* of the rocks above: no *primordial stones* are here to be seen, as those which happened to lie on this part of the *terrace* have been covered with fresh rubbish. Hence I descended to *Couvet.*

May 11*th* and 12*th*. On both these days it rained, and I was therefore obliged to defer carrying into execution the plans which I had arranged with M. Gallot; however, as it was fair on the afternoon of the 11th, I determined again to ascend the course of the *Reuse*, and I accordingly set out along the foot of the mountains on its left bank, where I likewise found abundance of *granitic blocks.* In consequence of the late rains, a part of the bottom of the valley was under water; but, as is the case in all inhabited spots which are subject to inundations, care had been taken to secure a path for foot-passengers from village to village. I wished to go first to *Motier-Travers*, on the right bank of the *Reuse* at some distance from the foot of the mountains; and along the whole way I found bridges of planks with large masses of granite laid between them. The water, though produced by a flood, was limpid, as no part of it descended in torrents; there were spots on the surface in which it disappeared, as I shall explain in the sequel: floods, therefore, are here occasioned by the overflowing of lakes in the internal parts of the mountains, wherein are deposited all the earthy particles, and whence issue many small streams, like the *Reuse*, which, flowing afterwards over the grass covering the bottom of the valley, do not become turbid, unless, in consequence of the abundance and long continuance of the rains, the water enters some of the exterior fissures of the mountains. Having crossed the river to *Motier-Travers*, I called there on M. Perrin, and likewise on Professor MONTMOLLIN, whom I had seen in my first journey into this country. Hence I went up the right bank of the *Reuse*, as far as the village of *Fleurier*, finding all the way as many *primordial stones*, as if I had been in one of the vallies of the higher *Alps*. I again crossed the *Reuse* by the *Pont des Roches*, in order to ascend to its source in that singular cavity of the mountain where the village of *St. Sulpi* is situated; its stream was now swelled to a much larger size than when I had seen it in my descent from the defile of the mountain, and it consequently issued from a greater number of fissures; but it still was perfectly limpid. It is impossible to view the mountains surrounding this spot without astonishment, and without a conviction arising from the appearance of their *strata*, which dip in every direction under a soil composed of rubbish, that their present elevation is the consequence of their having been supported by the borders of aninterior cavern, into which *sunk* the whole of the mass producing this valley by its subsidence. Near the entrance of the space thus enclosed, I saw in the mountain a smaller cavity, whence issued another limpid stream; and on going up to it, I found that there was, in this place, a large vacancy in the mass of the vertical *strata*, which being much fractured, a slope of rubbish had been formed at their foot; the stream issues from a crevice partly covered with these loose materials, through which it finds a passage; but the masses of *primordial stones*, here lying on the bottom of the valley, are not yet completely buried under the rubbish, for I saw the summits of some of them appearing above it; and as I returned from hence to *Couvet*, by *Boveresse*, I again found very large *blocks* of the same stones along the foot of the mountains.

May 13*th*. I went to *Travers*, in order to call on M. Gallot, and proceed with him on the first of our projected excursions, in which we were to observe a remarkable spot near the lower part of the *Val de Travers*, distinguished in my map by the name of *Cul du Van*, but commonly called *Creux du Vent*; because, as it is seen from a great distance, the phenomena of the clouds observed here are considered as affording prognostics of the weather. This is a vast recess in the form of an amphitheatre, cut down from the top nearly to the bottom of the mountain on the right bank of the *Reuse*; and that I may not interrupt my description of the geological objects belonging to this remarkable

48. As we went round the foot of *la Clussette* we saw on its talus large blocks of *lime-stone* detached from the rocks above, but none of primordial stones; while in the parts to which no slope of this nature extended, we observed blocks of the latter kinds, and especially of granite, in great abundance; their mean distance from each other appeared to me not to exceed 10 or 12 yards. This is a spot which M. de Saussure himself must have judged to be inaccessible to any stream arriving from the *Alps;* for against such a stream, the passage must have been closed by the mountain of *la Clusette;* and the channel which the *Reuse* has found here is but a very narrow one. This is, however, the only part where there has been any possibility of opening a communication between the *Val de Travers* and the lower grounds; but the road which is made here has required prodigious labour; it is kept up at a great expense, and is really one of the curiosities of the country. In order to carry this road round the very steep extremity of the mountain, it has been necessary, the whole way, to excavate the rocks, which form over it a kind of roof. But the greatest difficulty has been to construct a parapet for the security of passengers, on the side descending in a precipice; here also, the rocks, much shattered, have been excavated for the foundation of a wall; and the expense of keeping up the road is occasioned as well by the giving way of this wall in many places after rains, frosts, and the melting of the snows, as by the large masses which,

at those periods, fall from above, and either beat down some part of the parapet, or obstruct the way. We passed along this road, though in a direction opposite to our own course, to which we afterwards returned by a foot-path formed along a higher part of the mountain, and serving as a communication between several villages; this path also frequently crumbles down, but is repaired at little expense. It was hence that I observed the phenomenon of the mist in the *Creux du Vent*, as we were returning towards *Noiraigue*.

49. At this place we passed over a bridge which brought us to the extremity of a promontory advancing from the mountains of the right bank, and forming a part of the curve of the *Creux du Vent*: I had never any where seen the phenomenon of the *blocks* of *granite* more striking than at a certain height on this promontory: when viewed from a distance, their size and their abundance gives them the appearance of one of the hamlets common among mountains; and they lie so near each other, that the intervals between them are only narrow passages covered with grass. The first of these blocks which we approached was at least 25 feet in length, and from 10 to 15 in breadth and height, not reckoning the part buried in the ground; the others measured from 10 to 15 feet in every direction. In the sequel of these volumes, I shall describe granitic chains, in which will be found similar assemblages of *blocks* of *granite*, no less really extraneous to the

neighbouring strata, than are the above to these
careous mountains.

50. The *Creux du Vent* lies behind this pror
tory, which, as I have already said, constitut
part of its border, forming a semi-circle about t
quarters of a league in diameter in the upper p
but the *strata* are in very different situations in
semi-circle; in the part which meets the body of
mountain, and which I judged to be about 500
above the bottom of the cavity, the *lines* of
strata are nearly *horizontal*, as is seen in the ab
side remaining naked, at the foot of which
rubbish crumbling down from it has formed a sl
in some places rising half way up to the top,
evidently still increasing, for it is bare above,
consequence of frequent falls of new mater
But in the other part of the border formed by
promontory, the *strata* are nearly *vertical*, and
sent their planes towards the cavity, their very ra
slope being covered with firs, growing in the rubl
which extends even over the summit: the partic
point of this great change in the situation of
strata cannot be distinguished; and it is only
some spots where the rubbish has not been retai
on the slope, that their planes appear. A
observing the state of the rocks which on all si
encompass this cavity, together with the moun
of *la Clussette*, and a vast hollow in an adjoin
mountain, of which I shall have occasion to spe
and after examining the bottom of this whole spa

it is impossible to avoid perceiving that a great *subsidence*, has here taken place; not merely, however, in the cavity, this being only the point of the greatest depth, the very *strata* which now form the surrounding hills having themselves subsided; and that the explosion accompanying this *subsidence* has expelled from within the masses of *primordial-stones*, which now, mingled with masses of *lime-stone*, are scattered over this scene of catastrophes.

51. Having been more accustomed to climb mountains than my companions, I determined from the cavity, to ascend and cross the promontory; it was not, however, without much difficulty, that I gained the summit, which is commonly called the *ass's back*, on account of the sharpness of its form when viewed from *Noiraigue*. On reaching its highest point commanding the mountain of *la Clussette*, I had a prospect of the *Val de la Sagne*, whither I went some days afterwards. I found the descent towards *Noiraigue* very steep, and even dangerous from a circumstance which I had not foreseen: I was to go down through a fir-wood; and the snow of the preceding days was still lying on the ground. Not meeting here with any path, I was obliged to descend at a venture, sounding the snow with a stick, in order to find firm footing; but I often sunk in it, and fell. On the upper part of the declivity, which consists entirely of *calcareous rubbish*, I did not perceive any *primordial stones*; but be-

low this slope they were scattered in great abundance.

52. Here I found my companions, who had gone round the foot of the promontory; and before I parted from them, I settled with M. Gallot another plan, for the next day; that of crossing the same mountains to *Gorgier*, near the *Lake of Neufchatel.* M. ANDRIER, Count de Gorgier, formerly an officer in the Prussian Service, but at this time residing on his estate, was an intimate friend of M. Guyot, who had given me a recommendation to him, in order that I might first observe in that spot one of the remarkable phenomena of these mountains; namely, *strata* of *marl*, intermixed with those of *lime-stone:* and M. Gallot being also very well acquainted with this gentleman, he was so good as to offer to accompany me, in order to shew me the way to his house.

May 14*th.* We set out from *Travers* about noon; and after having crossed the *Reuse*, we approached the mountains on the right bank of the river. At first the ground here rises insensibly to one of the *terraces* of which I have spoken, where I again saw fragments of *primordial stones* mixed with those of *lime-stone;* but when we were on th slopes formed by the crumbling down of the rock above the *terrace*, we no longer found any but the latter kind. Thus we may every where trac

th

the history of this *valley*, from the epoch of the origin of the *continent:* the *terraces* bordering the foot of the mountains are masses of *strata*, which have suffered a greater subsidence than those composing the mountains themselves, and which, while still at the bottom of the sea, were covered with fragments thrown out from within by the expansible fluids, when compressed in interior *caverns*. On account of the greater subsidence of the masses separated from those which remained as mountains, the sides of most of the latter were left abrupt, with their *strata* much shattered, and in great disorder; in consequence of this, they have crumbled down; and the *slopes* formed by their *rubbish* having extended some way on the *terraces*, they have covered the *blocks* and other fragments of *primordial stones* which happened to lie there.

53. On reaching the summit of the mountain, which is every where interspersed with *hillocks*, we proceeded towards *Provence*, a village at the head of a kind of half tunnel, or rapid *combe*, beginning between *Mont Aubert*, and the mountain which we had just crossed, and descending down to the border of the lake. On the declivity of this *combe* we found a great abundance of *blocks* of *primordial stones;* and this is certainly one of the situations in which alone M. de Saussure imagined it possible that these masses could be found, the horizon being here bounded by the chain of the *Alps;* but I have already shewn that they are scattered in the same profusion

along the foot of all *mountains*. Now in this part of the country, it is in *hills* of this kind that the *strata* of *marl* have been discovered; and from their situation, we may judge of the nature of these catastrophes as clearly as if they had taken place before our eyes. Count DE GORGIER told me that the *marly strata* of this canton are found at the surface, being covered only, like the neighbouring soils, with rubbish of stones of every class; and that their bottom has never yet been reached: the cause of this will appear, in the sequel, to be, that the *terrace*, in this part bordering the *Lake* of *Neufchatel*, is a mass of *strata* which, in their subsidence, have become nearly *vertical*, presenting their *section* at the surface, where, consequently, is found that of the *strata* of *marl*; thus, when pits are here sunk in them, it is in the direction of their *planes*; but in other places, their situations are different.

55. This *marl* is hard when it is taken out of the pits; but after having remained for some time laid up in heaps in the open air, exposed to the sun, the rain, and the frost, it is reduced to powder: the *marine bodies* then appear; but the *shells* themselves having been, for the most part, destroyed, during this change in the substance which had contained them, scarcely any thing remains but the *marl* moulded within them, and petrified: I saw among them many kinds of *bivalves*, and among the *univalves* were *turbinites*, *echinites*, and *cornua*

Ammonis; there were also nuclei of the *nautilus*; but these are seldom found entire, because they so easily separate in the divisions of their concamerations. Before the *marl* has been exposed to the air, many nuclei are detached from it which retain their *shells*; I saw them on *mother of pearl nautili*; on *echinites spatangi*, on *ostreæ*, and on tubes of some species of *vermiculites*; on the outer part of these shells there are commonly *pyrites*, which I observed likewise on the *cornua Ammonis*; and the cells of the latter are mostly filled with *spar*.

36. I must here say something of the use of this *marl*; which, being buried under the stony rubbish, had been discovered but a few years before I visited the country, and by which the product of all these lands has been very much increased. The immediate advantage arising from it is that it so greatly promotes the growth of *lucerne*, of which many artificial fields have consequently been formed; and the manner of using it for this purpose is also a discovery; for if the following process were not exactly pursued, the *marl* would produce but little effect. The soil being first reduced to a very even surface, the *lucerne* is sown, and is afterwards covered to the thickness of about 2 inches, with this pulverized *marl*. The *lucerne* then thrives so greatly, that, so long as any *marl* remains on the surface, which is the case for several years, it yields every season four or five crops of excellent fodder; but in the course of time, the *marl* being washed

into the ground by the rains, the crops suffer a great diminution. On digging up the earth, it is easy to judge, from its colour, to what depth the *marl* has sunk: when it is found to be about half a foot below the surface, the land is ploughed in order to bring it up again, and fresh *lucerne* being sown, the crops, for some years, are again plentiful; but when the *marl* disappears a second time, the part before left in the ground having then sunk to a greater depth, little effect is produced by another ploughing, and it is necessary to lay on a fresh quantity of *marl*. The fodder thus produced has occasioned a considerable increase in the number of cattle kept in this country; and as there is consequently a much greater quantity of manure for the fields, and especially for the vineyards, the latter are become much more productive than they formerly were.

May 16*th*. Having mentioned to the Count my wish to observe a different part of the mountain as we returned to *Travers*, he was so good as to send a guide to shew us the path up the rapid side rising above *Gorgier*. The ascent, in which we spent two long hours, was at first entirely over loose fragments, and among these were many of *primordial stones;* but we saw no more of the latter, when we came to the slopes composed of the rubbish falling from the rocks above. On reaching these rocks, we perceived their *strata* to be nearly *vertical*, dipping towards the *lake;* whence it evidently appears that the *terrace* below is a mass of the same *strata*, which separated from those that slipped down to a greater depth in the *cavern*, and in which, consequently, the *marly strata*, descending almost *vertically*, have their section at the surface. As we ascended this slope, leaving the *lake* behind us, we had on the right a large recess of the same form as the *Creux de Vent*, which lay on the opposite side of this mountain, these two cavities being turned in contrary directions thus;) (; and both of them have manifestly originated in *subsidences* that took place in recesses of those great *caverns*, which produced on one side the basin of the *lake*, and on the other the *Vale de Travers*; the whole, at that time, being still beneath the waters of the sea. When we were on the mountain, we found its summit much undulated, but with softened outlines; there cannot be any doubt of its having been intersected by fractures, attended with different degrees of subsidence of the separated masses; but its ruinous state is concealed by a great thickness of rubbish covered with grass. We passed near the narrow part of the mountain which forms the division between the *Creux du Vent* and the opposite cavity; and leaving it on our right, we descended into the *Val de Travers* by a different path.

May 17*th*. Fine weather appearing at last to have set in, I determined to undertake one of those regular excursions which had been traced out for me by my friend Guyot; who, at the same time, had informed me what objects I should find most worthy of my observation, furnishing me with recommendations to his friends at every place in my way. None of these excursions, as will be seen in my accounts of them, could be made otherwise than on foot.

57. On quitting *Couvet*, I crossed the brook issuing from the cleft already mentioned in the terrace above the village, and ascended by a path up the right side of this little stream. On the *terrace*, I saw a mass of the *strata* of the yellow *lime-stone*, inclining towards the *Val de Travers*, and having its section turned towards the mountain. It is here known by experience, that, wherever masses of these *strata* lie in the above direction, if the rubbish under the section towards the mountain is cleared away, *strata* of *marl* are found beneath them. Of this fact, no attempt has been made to discover the cause; but it will be seen in the sequel to proceed from the following circumstance; that, in the fall of the masses of *strata*, which were divided from the rest remaining at a higher level, the inclination assumed by these masses, towards the space where the greatest subsidence took place, occasioned the *strata* of *lime-stone* to separate in the lines where those of *marl* lay between them; and the *marl* sliding forwards over the *lime-stone*, each fragment of the latter was accompanied in its descent by the portion of the former which had originally laid beneath it, and which it still continued to cover, though in an inclined position.

58. As I continued to ascend, I came to a high *combe*, terminating, on the left, in another large cavity similar to the *Creux du Vent;* but the abrupt rocks by which this is encompassed do not shew, as is the case in the former, any horizontal lines marking the separations of their *strata;* being only stony masses, projecting without order, from the top of which, through a cleft, the brook above mentioned rushes down in a cascade: of this advantage has been taken, by excavating the rock and erecting a mill under the first fall. I ascended by the side of the cavity, towards which, when I reached the cleft whence the brook issues, I saw the *strata* of the mountain dipping; the projecting rocks are the masses that have fallen in disorder.

58. *a.* My friend Guyot had particularly recommended to me to observe this mountain; and it will be seen that he had very good-reason for giving me such advice. The intersections in the higher part of the side on which I had ascended were those of the upper section of the mass of *strata,* of which the *planes* descend on this side. The indented edges of these *strata* form a *ridge* of small eminences which borders the brow of the precipice, and extends to a great distance in the same direction. I saw immediately that this *ridge* was produced by the irregular rupture of the mass of the dipping *strata;* and hence I was led to discover the cause of what I afterwards observed; namely, a number of similar *ridges,* parallel with the first, and nearly

at equal distances from each other, which intersect the whole summit of the mountain, their intervals being covered with grass: these *ridges* extend a great way in the direction which I was to follow in order to descend into a beautiful *combe*, wherein are situated the villages of *Cnaux d'Etulières* and *Brevine*. On viewing this summit, it cannot be doubted that the mountain itself is a mass of *strata* which has undergone an *angular movement* on the edge of the *caverns* that have occasioned the vacancy now called the *Val de Travers;* that this mass has been separated by a *fracture* from the other masses which compose the neighbouring mountains; and that, during its fall from its original height, certain repeated associations of the *strata* adhering most firmly together have slipped one over another, leaving at the highest level the parts now forming these parallel *ridges*. I shall presently mention some astonishing effects of the same catastrophes; but I must first make a remark of a more general nature, to which I am led by the great discovery of M. de Saussure.

59. That all the *strata* which compose these *mountains* were originally formed in a *horizontal* and *continuous* situation, on the bottom of the *sea*, is a point whereon no doubt can be entertained, because of the *marine bodies* contained in them; but, in the following travels in other countries, I shall have occasion to describe some *mountains* which though they consist of *primordial strata*,

schistus,

they afterwards sank into an aperture in the neighbouring mountain; there were meadows between this aperture and the border of the *pool*, near which was a small hill covered with fir trees. In 1632, the *hill* suddenly sank below the level of the *combe*, leaving in its place a deep hollow; and thus the *pool* became a *lake*, which still finds a discharge in the same aperture. This *lake* is the property of the owners of the sunken land, who, in the course of time, have recovered out of it all the fir-trees, which rose to the surface of the water as soon as their roots were disengaged from the diluted soil: and the fishery now yields them a greater revenue than they enjoyed before this change; for, by degrees, the brooks which flow into the *lake* have fully stocked it with fish of the best kinds.

62. The works of art in this spot are also very surprizing; for no people excel the inhabitants of these mountains in diligence and ingenuity. As the lake, by its great extent, presents an immense reservoir of water for the supply of mills in times of drought, they conceived here the bold idea of placing mill-wheels on the course of the water within the mountain. For this purpose, they first constructed a dike, at the extremity of the lake next to the aperture, in order to obtain a current constantly equal; and thus the level of the lake is raised, while, by means of a sluice, the same quantity of water is at all times drawn from it. After this, they widened the aperture through which the water flows into the mountain, excavating on its course two spaces, one

below the other, wherein two wheels are placed, and cutting on the side a road formed into steps, with a rail, for the purpose of descending to them. The water, after having turned the first wheel, falls into a basin hollowed out to receive it, from which it is directed to the lower wheel; and it is afterwards lost in the heart of the mountain. The machinery set in motion by these wheels is placed in a building solidly constructed above this abyss, into which I descended as far as the lowest wheel; the upright beam of the latter turns only a corn-mill; that of the upper one is shorter, and may be used occasionally either for a corn or a saw-mill. The water which falls on these wheels, as is generally the case in overshot mills, is led by moveable wooden troughs, and by levers, extending to the mill itself: the miller, when he chuses, can turn off the water from each wheel, and bring it back again, without going out of the mill.

63. The stream is kept as clean as possible, by a grate placed on the outside of the aperture, for the purpose of intercepting the leaves, and other floating bodies, which might choak up its narrow passage below the wheels; but notwithstanding this precaution, its course is sometimes obstructed; the water then rises in the cavity, and the wheels are stopped. On such occasions, the sluice is shut, that no more water may fall into the cavity; and when that which already fills it has run off, men descend by the steps to the place where the obstruction has taken place, and clear out the mouths of all the crevices with a

pole; a sufficient quantity of water being afterwar let in, to carry off the bodies lodging in them, whic have been thus put in motion. Nothing more bein necessary to restore to the stream a free course, must evidently fall from hence into a more spacio cavity; for not only would its channel be again ol structed, but there would be no possibility of remo ing the obstruction, if the passage of the water co tinued to be equally narrow below the point withi reach of a pole, or of iron bars with hinges, whic are sometimes used if the resistance is great. Th subterranean brook is believed to be one of thos that unite, within the mountain, to form the sma river *Reuse*, which issues from its foot at *St. Sul* in the *Val de Travers*, at a considerable distance fro this spot. When the water rises above the dike, is carried off by a canal running parallel with th which supplies the wheels.

63. *a.* A similar phenomenon is observed high up in the same *combe*, near *Brevine*, a village situate 1860 feet above the level of the lake of *Neufchatel* but the brook, which is employed there, turns th wheels before it sinks into the mountain. This broo issues from a *peat-moss* in the upper part of th *combe;* it has excavated a channel for itself amon fragments on a rapid slope near the village; at th top of the slope, a reservoir has been formed, b means of a dike, whence the water is led by a can to fall on a mill-wheel; after which it is lost in heap of rubbish under a rock: when this stream

so much swelled as to rise above the rubbish, it passes off by some crevices in the rock; so that the inundation never rises up to the mill. Here then we find a second brook which loses itself in the mountain, and of this the issue is not directly known; but it will appear more and more evidently that there are interior *caverns*, wherein these waters are collected, and whence they issue in various places, without any known reference to the passages by which they have entered.

64. At *Brevine*, my friend Guyot had recommended me to M. Montandon; and to M. Simon Matthey; and as he had mentioned, at the same time, what were the objects which he particularly wished me to observe, these gentlemen very obligingly offered themselves as my guides. They first shewed me a *marl-pit*, in a situation very similar to that already described near *Couvet*, on the other side of the mountains; and here I found some *terebratulæ*. Hence they conducted me to *Mont Chateleut*, which is at about a league's distance, on the territory of *Franche-Comté*. This mountain was formerly much celebrated for its fine *fossils*; but a spring of mineral water in the neighbourhood had now, for some time, been very much frequented; and the summit of *Mont Chateleut* forming a very interesting belvidere, it had become a favourite walk with the visitors of this spring, who had picked up all the fossils which had caught their eye; so that gleaning after them, I could find nothing but fragments: by these, however,

I became

became acquainted with the various species of t *fossils*, of which I afterwards found it useful to ha obtained a knowledge.

65. In our way to this mountain, we ascended, the village of *Cuches*, towards a ridge of eminence over the summits of which passes, for some league the limit betwixt *Franche-Comté* and the country *Neufchatel*; we crossed that line between *Mont* *l'Armon*, 2480 feet above the level of the lake *Neufchatel*, another of these eminences; and hen we reached *Mont Chateleut*, which is an insulat mountain, in the form of a truncated cone, risi 214 feet above *l'Armon*. Besides the eminenc that compose the regular ridge already mentione many others are dispersed on both its sides, some which are covered with fir-woods, and some wi downs, according to the nature of their surface. clearly appears, by the situation of the *strata* in t country, that they have all undergone a *subsiden* with *fractures* and *angular motions*; and that t *eminences* consist of the masses which have remain at a higher level than the rest. On some of the eminences are projecting rocks, where the *strata* seen in their sections to incline towards every poi and to follow different directions: they are eve where in great disorder, but less so in the eminen bordering the *combe* of *Etalières*, than in those alo the upper part of a deeper valley in which flows t *Doux*; *Mont Chateleut*, whither these gentlem were so good as to conduct me, is among the latt

a

and from this mountain they returned to *Brevine*, as I was afterwards to proceed by a different road.

66. The cause of the conical form of *Mont Chatelat* is, that its slopes, which descend very low on the side next the valley, are composed all around of fragments; I could scarcely discern the *strata* except on the summit, and there they appeared to be horizontal. These *strata* consist of a hard *limestone*, on which the actions of the air produce but a slow effect, leaving the *marine bodies* contained in it in relief on the surface, whence, however, it is scarcely possible to detach any without breaking them; such as have been found here loose have proceeded from *strata* softer than these, and of a marly nature, the sections of which may in some places be seen through the rubbish on the slope. The first ramblers, who chanced to take notice of these *fossils*, found them on the slopes, and selected such as were in the best preservation; after great rains, which wash away the smaller particles of the rubbish, more specimens of this kind may still occasionally be found; but for me, as I have already said, I met with only fragments, neglected by former collectors, yet sufficient to make me acquainted with the various species. I saw here some *terebratulæ*, and several other kinds of *bivalves*; but especially an immense quantity of small *ostreæ*, one of the valves of which was convex, like the half of a nut-shell, and the other nearly flat; there were also great numbers of *entrochi*, most of them separate, but some still con-

nected together in small columns, many kinds
coralline, and many spines of echinites resemb
spikes of plantain; the echinite to which these sp
belong, and of which the mamillæ are large, is so
times found here entire; but I saw only fragme
of it. I was told that, towards the bottom of
slope, there were marl-pits; always an indicatio
the subversion of the strata.

67. From the top of this hill is seen, at some
tance, a great extent of the valley of Morte
through which the Doux winds before it enter
defile, that had been mentioned to me by M. Gu
as worthy of my observation: with this view, he
recommended me to M. FAVRE, the clergyman
Les Brenets, whither it was my intention to proc
this evening. The slope towards the Doux is in
rapted by a vale, bordered on the side next the ri
by another ridge of eminences, manifestly appear
from the situation of their strata, to be masses s
ported on the edge of the long cavern, which, w
the rest sunk into it, produced the valley of Mort
Following this high vale, I passed through the vill
called Derrière-le-mont, whence descending towa
the Doux, I came to Moulin-Bonnet. From
place, the river continues to wind through mead
to a small lake surrounded with mountains: I
not follow it so far, but quitted its banks, in ord
ascend to Les Brenets. I came first to a ter
from which I had a view of the village; but be
reached the latter, I had to cross the lower par

in our prospect. The weather was perfectly serene; and as the smooth bosom of the *lake* at once reflected the sky, and extended the rocks to a great depth below the surface of the water, we might almost have fancied ourselves borne through the air by an eagle.

68. M. Favre informed me of the regulations observed in the management of the woods, which rise one above another, and border the whole of this defile of the *Doux*. The trees, being planted on these slopes composed of rubbish, would be blown down by high winds, if they were suffered to grow above a certain height. Now either accidentally, or by the design of the first planters, the *firs* and *beeches* are here equally intermixed; and they are cut down in such a manner, that a line of them appears, at one time, to consist almost entirely of *firs*, and at another, of *beeches*. The *roots* of the latter, remaining in the ground, are continually throwing out fresh shoots, which, by their shade, preserve moisture in the soil, and afford shelter to the young *firs* springing up from seeds. These *beeches* are felled whenever their stems have attained to a sufficient size; and by that time the *firs* are large enough to give shelter, in their turn, to the new shoots which rise from the roots of their former protectors.

69. When we were near the lower extremity of the *lake*, the noise of the discharge of its waters by the *Saut du Doux* began to interrupt the silence of

this solitary spot; and quitting our boat, we walked on to view the cascade. The sides of the valley here approach each other, and assume a quite different aspect. I have already said that around the *lake*, as well as to a certain height on the course of the river above it, these sides are composed of several *terraces*, which are the result of successively greater *subsidences* of masses of *strata*, separated by fractures: but below this point, the divided masses have turned during their fall, so that, on the sides of the *defile*, they present the planes of their *strata*, but in the greatest disorder. One of these masses lies at the lower extremity of the *lake*, which discharges its waters in various *cascades* from rock to rock; and here I saw a circumstance common to all *cascades*, (as I shall shew by many other examples in the course of these travels) and affording a proof that cataracts do not erode the rocks down which they fall: these rocks, while the water precipitates itself from their edge, are covered beneath it with *moss*. From all these particulars, it is very evident that the *Dour* has not *hollowed out* the deep *valley* in which it flows, but, like all other mountain streams, has followed a course prepared for it by the *catastrophes* of the *strata*: a greater *subsidence* having taken place in a part of the bottom of this pre-existing *valley*, and the issue of the cavity thus produced being as high as its entrance, the river has there formed the *lake*, from which a more continuous and greater *subsidence* below has occasioned it to fall in a *cascade*; and though above, where it maintains its own channel in slopes composed of rubbish, it has spread this rubbish over all the wider parts, now covered with grass, and converted into meadows, it has not yet been able to *fill up* the cavity of this small *lake*.

70. After having passed the *Saut*, we ascended by a path among the rocks to the place called *Corps de Garde*, on the first *terrace*, on which we then turned back, and proceeding behind the scalloped rocks that border the right side of the *lake*, we thus returned to *Les Brenets* by a different road. M. Guyot, in his itinerary, had recommended to me, in my way from *Les Brenets* to *Locle*, to pass through *Roche-fendue*, (the *cloven rock*) in order to observe that spot and its vicinity. The carriage road crosses these eminences at a different point; for though *Roche-fendue* presents a passage very convenient to the goats, it is one of which few men are able to avail themselves, even on foot. M. Favre and one of his friends were so good as to accompany me thither in the afternoon.

71. On setting out from *Les Brenets*, we first ascended a mountain called *Chatelar*, which is of the same nature as that of *Chateleut*, though the latter lies at such a distance to the west; the *strata* of both these eminences are the same, and they contain the same *marine bodies*; especially those small *ostreæ*, of so peculiar a kind, which I have described on *Mont Châteleut*. These *strata* must certainly have extended over all this part of the bed of the ancient sea;

other side of *Les Brenets*, near a hamlet called *Rancenier*, whence they flow to join the *Doux*. This interior passage has been also used for the construction of mills, and even on a larger scale than I have already described near the *lake* of *Etalières;* for not only are three wheels placed here one below another, but the mills themselves are within the mountain, nothing being above ground except the houses of the millers: the last of these mills, as is indicated in my map, is more than 300 feet below the entrance.

73. Had not the waters found this singular discharge, the whole vale of *Locle* would have formed a lake; and such indeed a part of it sometimes becomes; because, when there is a great abundance of water, it cannot all pass off through the lowest crevices, and must therefore rise till it meets with others at a higher level. This was the case when I arrived here; for the water, swelled by the late rains and melted snows, had risen very much above its common passages, before it could find crevices sufficient to carry it off: the lake thus formed extended to within half a league of *Locle;* and as the quantity of water which now entered the mountain did not find a sufficiently quick discharge below, it had already covered the wheel of the lowest mill. On the free passage of the water under ground, the safety of this beautiful village entirely depends; for any obstruction there would occasion the water to rise to a much greater height, before it could find a discharge through the crevices

in

74. Ascending over the commons belonging to *Locle*, we left on the right the largest eminence of the first chain, called *Mont de la Joux*, which rises 2300 feet above the level of the lake of *Neufchatel;* and we came to a part where this chain is double, a village lying in the interval formed by its division being called *Entre-deux-monts.* We then ascended an eminence belonging to a third ridge, called *Mont du Cré*, whence we had a view of the whole *Val de la Sagne*, which is about four leagues in length, from *Boinou*, situated in its highest part, on the N. E. to the village of *Brot-dessus*, at its lower extremity, in the part nearest to the *Val de Travers.* Another ridge of eminences, the highest of which, called *Téte-de-rang*, is 2660 feet above the level of the lake of *Neufchatel*, separates the *Val de la Sagne* from the *Val de Rus* to the eastward of it: the soil of the latter vale is nearly 700 feet lower than that of the former, towards the chief place of which I descended; it is called *Cré de la Sagne*, and it is here that the church stands, with a few of the houses of a village scattered over the whole of the vale.

75. Except in the vallies of *Silesia* and *Lusatia*, I have never seen villages similar, either in nature or in length, to this which occupies the *Val de la Sagne.* It is built along the feet of the eminences on both sides of the vale; both these rows, which extend out of sight, consist of very neat farm-houses in good repair, at about the distance of two gun-shots one from another, every house being surrounded with

gardens and orchards: behind each row is a wide terrace, extending as far as the foot of the woods, which rise to a certain height, with little acclivity, on slopes composed of the rubbish falling from the rocks above. These terraces are cultivated, and are very fertile: the vale itself, which is of great breadth, is a *peat-moss;* the water flowing through it sinks into a cavity in its lower part, and is the same stream which I mentioned, § 47, as issuing from the foot of a rock at *Noiraigue;* a name obviously originating in the times when this vale was in its natural state, the water of *peat-mosses* being always of a dark colour; but the stream issuing from it is now limpid; because the formation of *peat* is at an end, the ground having been drained and brought into cultivation. This *peat-moss,* like so many others which I have elsewhere observed, was first occupied by a forest, here consisting of fir-trees; but when the *peat* became deeper, these trees, being chiefly rooted in it, were overthrown by the wind, and afterwards buried in the *peat* as it continued to increase.

76. The inhabitants of this place, who are [illegible] holders, all possess nearly equal portions of [illegible] *peat-moss,* of the terrace behind their houses, [illegible] the woods above; and they appeared to [illegible] living very comfortably. Entering into [illegible] with one of these peasants respecting [illegible] peculiar circumstances of the vale, I [illegible] [illegible]tunity of clearing up to him a difficulty [illegible] much perplexed him. I had seen, [illegible] [illegible]

the fields, some heaps of branches and roots apparently taken but lately out of the *peat-moss*, notwithstanding it had long been cultivated; and I asked him where this wood, not yet dry, had been found. " Anybody would suppose," answered he, " that it " grew under our lands; for though we have had " them so long in tillage, yet every now and then " the plough is stopped in one place or another, " where it had passed freely the year before, by " some of these branches; and we are often obliged " to dig to a great depth to take them out." Of this difficulty I gave him the following explanation, which he thought satisfactory. This wood had lain at first at the bottom of the *peat-moss*, where it had been covered by the rising peat. The vale having some declivity, its surface was easily drained to a certain depth by cutting ditches in it; thus it was made to produce good grass, and it has since been cultivated. When the *peat*, which is of a very spongy substance, is exposed to the air by tillage, and mixed with manure, it is soon reduced into *vegetable earth*. Its volume thus diminishes considerably; so that, as the *stratum* of *peat* covering the *wood* becomes gradually thinner, pieces of wood more and more deeply buried in it are successively reached by the plough, which always penetrates to the same depth below the surface; and this will continue to be the case, till the change of the *peat* into *earth* shall have extended so far down, that the lowest part of the *peat* shall undergo no farther subsidence; but I do not believe that the fertility of the surface will be then improved.

77. I had great pleasure in passing along a part of this line of rural habitations, in my way to the pretty village of *Ponts*, or *Pont Martel*, situated on the right in the lower part of this valley; and having rested myself there for a little while, I inquired the way to the spot where the waters of this vale disappear. Here I saw the principal stream, which is the same that issues forth at *Noiraigue*, and which, after having flowed a certain way in a deep furrow of the surface, sinks into a cavern under a rock; but besides this, there are rills that discharge themselves into a kind of tunnels in the surface; these tunnels, to the bottom, are covered with grass, in which the water loses itself. This is one of the most remarkable phenomena belonging to these mountains; and I shall have occasion to describe it more particularly in other spots.

78. I presume that a discharge or filtration of a different kind has formerly taken place here, that is to say, of *tar;* this substance being extracted near *Pont Martel*, in the *Val de Travers*, from an argillaceous earth, which is there called *mine of asphaltum.* This earth is put into a tub, where being diluted with boiling water, the *tar* rises to the top, and is used for greasing the axle-trees of carts. Now this same substance is also found in the earth of some parts of the country of [illegible] [illegible] casks with their staves loosely joined [illegible] [illegible] the bottom of pits dug in the [illegible] [illegible] water in rainy seasons, and the tar [illegible]

the surface, is taken off. Mentioning this fact in my *Lettres sur l'Histoire de la Terre et de l'Homme*, I founded on it a conjecture, that the water of *peat-mosses* might derive the *antiseptic* property, by which the plants growing there, being preserved from the *putrid* decomposition undergone by those in *marshes*, are enabled to retain their *combustibility*, from the *heath* wherewith all the *peat-mosses* which I had hitherto seen had been covered; as must formerly have been the case likewise in the *Val de la Sagne*, where *heath* still grows in some of the lower parts. But I am now fully satisfied, that, though *heath* may produce *tar*, it is by no means the source of the *antiseptic* property of the water in *peat-grounds;* for in the volumes lately published of my travels in *Mecklenburg* and *Holstein*, and also in *Devonshire*, I have described very extensive *peat-moors*, on which scarcely any heath is found; whence I am led to believe it to be rather from the nature of the *soil* that the water of these *moors* derives its *antiseptic* quality.

79. I have not, for a long time, spoken of any masses of *primordial stones;* for, besides that my attention has been directed to other objects, they probably have been cleared away in these vales, which are covered with pastures; but I began to observe masses of this kind at *Cré de la Sagne;* and at *Pont Martel* I saw them in great abundance. Proceeding from hence towards *Couvet*, I followed the highest part of the *terraces*, which I found much

intersected with vales and combes; and on this road I likewise saw *primordial stones;* but when I came to the village of *Plancemont*, situated at the head of the large *combe* which terminates in the intersection above *Couvet*, I found its slope covered with so vast a quantity of *granitic blocks*, as to confirm my servant in the opinion that he had formed on the opposite side of the valley near the castle of *Motier Travers*, which was now within our view, that these *stones* had come from *beneath the ground;* for he had observed, that, along the whole of our way, none of a similar nature had appeared in any of the *rocks*. Having descended this *combe*, we passed through the above intersection, and arrived at *Couvet* about seven in the evening.

May 20th. There was another part of the *Val de Travers* that I wished particularly to visit before I quitted it. I have mentioned that a long promontory, in which the *strata* are nearly *vertical*, and which is terminated by an insulated rock, divides this valley, near its upper extremity, into two branches: in that to the N. E. is the *cul-de-sac* of *St. Sulpi*, whence the *Reuse* issues; and it was the other which I designed at present to observe.

80 This branch of the valley terminates also in a *cul-de-sac*, there being no way to pass beyond it but over the mountains: among these is *Mont Chasseron*, which, as I have said, rises 3558 feet above the level of the lake of *Neufchatel*. The small

river *Longe-aigue* is here formed by several rivulets issuing also from crevices in the rocks: it originates in two of these which gush forth from the foot of the mountains at the head of this space. The stream formed by their junction flows along the side of the promontory, where it unites with two others issuing from the foot of the promontory itself, near the village of *Buttes*, where one is immediately employed in turning a mill; the other is nearer the extremity of the promontory. These waters, when united, fall into the *Reuse* a little above *Fleurier*. The mill at *Buttes* is 1600 feet above the lake of *Neufchatel*. It cannot be doubted that, in the interior parts of the mountains encompassing this space, there are *caverns* in which are collected the waters passing off from the surface through the intervals and the crevices of the vertical strata; and that, from these internal recesses, proceed the rivers issuing forth at so many various points; for no permanent streams can be produced but from a reservoir, unless they flow in the long channels which are offered them by *vallies* where they collect the waters of all the springs on their sides.

81. The foot of the mountains encompassing this space is also bordered with *terraces* formed by masses of *strata* which have been irregularly stopped on the edge of the *caverns*, whence all this disorder has resulted. The *terraces* are covered with fragments, among which there are large *blocks* of *granite*, many of these being likewise scattered on the slopes in

every situation, as well on the higher as on the lower parts. On these terraces I made the circuit of the space enclosed within them; and I here saw the very disordered state of the *strata* at the foot of the mountain. I then crossed the entrance of this space to *Fleurier*, where I passed the *Reuse*, in order to return along its left bank to *Couvet*. From the consideration of this space alone, it is impossible not to perceive that the *Val de Travers* and its branches are only the point of the greatest *subsidence* of the *strata;* that even the masses which now form the *mountains* were originally at a higher level; that, having been broken, they have themselves *subsided* partially, their separated parts undergoing *angular movements;* and that the outermost of these masses have sunk lower than the rest, but have been retained on the edges of the deepest of the caverns. The disorder of the masses which descended to the lowest level will presently appear from the cavernous state of the bottom of the *valley*.

May 21st. I was this day confined by bad weather; but on the 22d I quitted *Couvet*, intending to make *Neufchatel* the central point of my next excursions; however I went first to *Travers*, in order to take leave of M. Gallot, in whose company I had made such interesting observations.

82. With this intention, I proceeded along the left bank of the *Reuse*, which I had not yet observed, and where I had been told I should see a very remarkable

able phenomenon; this consists of two natural *wells*, at some distance from each other, the largest being about 100 paces in circumference; they look like *ponds;* but I was told that, though they had been sounded by letting down into them a very long rope with a stone fastened to it, their bottom could not be reached: they are always full of clear water, of which the level varies little, except in very dry seasons, when it sinks, and after violent rains, when it rises so much as to run off in rills, constantly limpid, like the streams gushing forth from the foot of the rocks along the valley. These *wells*, which are on a terrace a little higher than the issues of the other streams, probably indicate the level of a large ramified reservoir extending under the *valley* from the interior part of the *mountains;* for with this reservoir it is only below that they can possibly have a communication. The growth of woods here even is prevented by the state of the *strata* on the bottom of the *valley*, and the *caverns* beneath. The surface is covered with rubbish, overspread with grass; but the rain waters do not remain on it, except in some places which are marshy, because the *strata* there present their *planes;* in other parts the water sinks immediately into the crevices of the *strata*, and disappears from the surface which cannot therefore afford nourishment to fores trees.

May 23d. I set out in the morning from *Travers* for *Neufchatel:* this road first led me through *Noiraigue*,

Noiraigue; and considering with more particular attention the rocks of *La Clussette,* under which I passed, I perceived what was the cause of their crumbling down so rapidly; they consist of the *thin strata* of the *yellowish lime-stone,* alternating with those of *marl,* and are all much shattered by the catastrophe from which their strong inclination has resulted. Here I saw that, notwithstanding the the difference of colour, this *lime-stone* differs but little its nature from the *marl;* for all the *strata* were penetrated, throughout their whole mass, with large blue spots. I said before that the same *marine bodies* were contained in both in the *marl* and in the *lime-stone;* only they appear more numerous in the former, from which also they are more easily detached.

83. The *Reuse,* on issuing from the defile of La *Clussette,* falls in a small cascade; below which it flows for some way through meadows, near the village of *Brot-dessous.* At this point, the mountains retire to a greater distance from each other; and in that on the left bank is the cavity which I mentioned, § 58, as in size and form resembling the *Creux du Vent;* but by the state of the cavity, and by that of this part of the bottom of the valley, the latter is shewn, still more and more evidently to be merely the point of the greatest *subsidence* of the *strata.* In the *Creux du Vent,* the *lines* of the *strata,* which are very distinct, are nearly *horizontal,* except in the promontory forming part of its

border, and advancing towards *Noiraigue;* while along the whole front of this cavity on the opposite bank, they are in such great disorder, that their situation can no more be distinguished here, than in many of the precipitous sides of the mountains which consists of those of the *primordial* classes; towards the lower part of the valley only, on the side next *Rochefort*, the *strata* are seen to be nearly *vertical.*

84. Below *Brot-dessous*, the *Reuse*, flowing along the foot of the mountains on the right in its way towards the *Lake of Neufchatel* by *Boudry*, enters another defile between the foot of these mountains and a hill, which, advancing from the left bank, stretches across the whole valley, leaving only a deep and narrow passage for the stream. Were it not for this passage, a *lake* would be formed here, and would rise to a considerable height in the valley. The road passes over the hill; and when I was on its summit, I was struck with a quantity of *blocks* of *granite* and other stones of the same class, which covered the slope, and extended down to the border of the *Lake of Neufchatel.* From this hill, there is a very fine view of the chain of the *Alps;* and persons who had not seen blocks of of a similar kind in the interior parts of that of the *Jura*, and even on its opposite side towards *Franche-Comté*, might easily suppose, with M. de Saussure, that these on the side next the *lake* had been brought from the *Alps* by that retreat of the waters

which he terms the *débacle*. I had much pleasure in passing along the summit of this transversal hill as far as the defile; for it commands a prospect extremely beautiful and interesting, as well of the upper part of the valley, as of the *lake* and the *Alps* beyond it. When I came to the brow of the defile, which is evidently an irregular fracture of the *strata*, I saw the *Reuse* winding along its bottom, and forming many small cascades.

85. The road from hence to *Neufchatel* leaves the river on the right; and when I came to those parts of the slopes on which the vineyards begin, I saw several *marl-pits* by the way-side, with many large heaps of *marl*, already pulverized, having been for some time exposed to the air; the *strata* whence this *marl* had been taken lay under those of the yellowish *lime-stone*, as will appear to be the case all along the mountains which extend across the interval between the *lakes of Neufchatel* and *Bienne*. I already knew, from M. Guyot's notes, that few *marine bodies* were here contained in the *marl;* and accordingly I found only some *terebratulæ* and *tubes* of *sea-worms*.

86. In approaching *Neufchatel*, I had on my left some abrupt rocks, under which flows the *Seyon*, arriving from the *Val de Rus:* this is a very remarkable spot, and I shall describe it in the sequel. The opposite side of the cleft that affords a passage to this small river rises towards other rocks, with a

gentle slope, which forms a very spacious vineyard. The succeeding rocks on the same side retire, to encompass the *Lake of Neufchatel*, and that of *Bienne* beyond it. The *Seyon*, no longer hemmed in by these rocks, flows towards *Neufchatel*, and there falls into the *lake*.

May 24*th*. My friend Guyot had provided me with recommendations to several of his acquaintances at *Neufchatel*, whom I visited in the intervals of my various excursions: following the directions contained in his notes, I employed this first day in ascending the foot of the mountains just mentioned, which border the beautiful suburb of *Neufchatel* extending toward the *Lake* of *Bienne*. This side of the mountains presenting an aspect favourable for the vine, vineyards have been formed on the lower part of their slopes, wherever the rubbish of the *strata* is of sufficient depth for digging. At the extremity of this suburb, there is a mass detached from the mountain and cut down abruptly on the side next the road the *strata* of which descend rapidly towards the *lake*: the upper part of this insulated rock has been levelled, and forms a very pleasant walk.

87. The neighbouring extremities of these two *lakes*, and the interval between them, (which I agree with M. de Saussure in considering as an alluvial product of the waves of these *lakes* and the sediments of the streams that enter them,) have been

already mentioned in my *Elementary Treatise of Geology*; this being one of the spots in which it most evidently appears that the *cavities* of *lakes* are only those parts of the *vallies* where the greatest *subsidence* has taken place; for it is in situations of this nature that we most commonly find large masses which have been detached from the mountains, and of which the *strata* dip towards the *lakes*: in the above work I introduced some particulars respecting this spot; but I shall now give a more detailed description of it.

88. I ascended to the top of the vineyards, which terminate in the upper part of the slope formed by the rubbish of the *strata* of foliated yellowish *limestone*; above this point, I found the *planes* of these *strata* entirely bare, and descending rapidly, under the rubbish, towards the basins of the two *lakes*. I could not have walked up an inclined *plane* of such rapidity, had not the *strata* been full of crevices, and in some parts rendered rugged by exfoliation. If the rain water flowed down this slope without interruption, it would destroy the vineyards by washing away their soil; but as it descends, carrying along with it the small flakes detached from the *strata* by the various actions of the air, it filtrates into the crevices lying in its course, and does not externally form any visible stream. In this lower part of the mountain, the plants, which shoot up in spring on the small heaps of rubbish accidentally collected on this sloping *plane*,

are destroyed by the heats of summer; so that nothing grows here but a little grass, and a few ligneous plants, the roots of which have penetrated into the crevices.

89. This first *plane*, or *tabula* as I shall call it, extends in length a considerable way towards the *lake* of *Bienne*, and rises to such a height, that, from some places at its foot, it might be taken for the mountain itself; but, on arriving at its summit, it is found to be abruptly cut down towards the latter, and to have under it, on that side, a slope composed of its own rubbish: here I could judge of the *thickness* of this mass, in some parts apparently about 200 feet, including the *marl*, which originally lay beneath the *lime-stone*, and occasioned it to slide down, in the manner described § 57. I descended by this slope into a longitudinal valley, and saw rising beyond it a second *tabula*, similar to the first: the lower part of this also is covered with rubbish, forming a slope like that which is occupied by the vineyards; but as vines cannot grow at this height, it has been left to itself, and is covered with grass. On ascending this second *tabula*, I again found, above the slope of rubbish, the naked *plane* of the *strata*. At the top, I came to another abrupt section of the same nature as the former; and by the slope formed under it, I went down into a second longitudinal valley, beyond which rises a third *tabula*, covered with *grass* to a certain height, like the preceding. On reaching the

summit of this last *tabula*, (also cut down abruptly on the side next the mountain,) I at last obtained a sight of the mountain itself, rising at some distance, and presenting towards me, above a slope composed of its own rubbish, the abrupt *section* of its *strata*. It is from this point that the whole mass of the three *tabulæ* has been detached by a fracture, and has fallen down towards the *cavern*, which occasioned the great *subsidences* whence resulted the basins of the *lakes*. The border of this *cavern* happening to slope, the falling mass, in its descent, was separated into these three portions, the separations taking place in the parts where *strata of marl* were interposed between those of *lime-stone;* for in the three *sections* turned towards the mountain, when the rubbish is cleared away, the former *strata* are found to lie beneath the latter. Had Mr. Playfair seen such phenomena as these, which may be found, as I have shewn in my *Elementary Treatise*, around almost all the *lakes* situated among mountains, could it possibly have occurred to him that these *cavities* had been produced by catastrophes, or any other causes, *modern* as he asserts, in comparison with those from which the exterior form of our continents has resulted? But this supposition, how strongly soever opposed by the concurrent testimony of facts, was necessary to his system, for the purpose of setting aside the *chronometer* formed by the *progress* of the *sediments of rivers* at the entrances of all *lakes*, and especially of those in the country of which I am now speaking.

90. M. Guyot had particularly recommended me to his intimate friend M. MATTHEY, Receiver at the Castle of *Neufchatel*, with whom he had made many excursions in these mountains, and who was acquainted with every part of them. This gentleman was one of the first whom I visited here; and M. Guyot's letter having informed him what were the spots which he chiefly wished me to observe, he was so good as to offer to accompany me the next morning some part of the way, and then to leave me to the care of other guides; as he could not himself be absent from *Neufchatel* so long as the whole of my plan would require.

May 25th. We set out on foot from the city, taking at first the road by which I had entered it, along the right bank of the *Seyon*. Having already observed the mountains on the side extending towards the *Lake* of *Bienne*, I could easily perceive that here a greater *subsidence* had taken place, whence had resulted the lowest part of the valley leading towards the *Val de Travers*; for I saw, at the entrance of this valley, the lateral sections of several *tabulæ*, similar to those described above; and M. Matthey told me, that, in some parts, there are not less than five of these, which are in the form of sloping roofs, each descending lower than that behind it, and advancing farther forward in the valley; while the mountain above presents an abrupt section, shewing from what point have been detached these masses, which, in falling, have

slidden

slidden one over another, their separation always taking place along the line of a stratum of *marl*: the *tabulæ* here, however, are not, in every part, so continuous as those which extend towards the *Lake* of *Bienne*, for in some spaces they are interrupted, and have not preserved the same level on the opposite sides; and there are also, in the vallies, some insulated mounts of a similar form, in which *marl* is found under the *strata* of *lime-stone*. Thus the discovery of this *marl*, so beneficial to agriculture, has not been less advantageous to Geology; since it enables us to trace the progress of the catastrophes of the *strata* with as much precision, as if they had taken place before our eyes; clearly shewing, at the same time, that by these catastrophes have been produced the *vallies* and the *cavities* of the *lakes*.

91. We continued to ascend the course of the *Seyon* along the right bank of its deep channel, till we came to the spot where it issues from the *Val de Ruz* through an opening in the mountains: near this opening, we crossed the river on a bridge, and followed, on its left bank, a terrace bordering the deep precipice at the foot of which we saw it flow. This is the road from *Neufchatel* to *Valangin*; and it is the only way to a spot where lies a *block* of *granite*, so remarkable as being the largest known on these mountains, that it is designated in the map of the country by the name of *Pierre à Bot*: its form is sufficiently regular to have enabled

M. Matthey

M. Matthey to take an exact measurement of it, according to which, the part that rises above the surrounding rubbish contains 14,000 square feet; thus this exterior part alone is equivalent to the cube of about 24 feet. On examining the recess in the mountains in which this mass is found, entirely encompassed with eminences wherein the *strata* are in the greatest disorder, it evidently appears to be only from the interior part of the soil that such a *block* can have been thrown out on the surface.

92. Near this spot is a *marl-pit*, of small use for agricultural purposes, yet interesting of its kind: very little of the *marl* remaining in it is susceptible of pulverization by the air, being *petrified* in large masses, much resembling the *Namur stone*, as it is called, which is employed for building along the course of the *Meuse* as far as *Holland.* It is a blackish grey *marble*, is very hard, takes a fine polish, exhibits, where broken, a shining surface, and is intersected with veins of *white spar* containing druses in their vacancies. From these indurated masses there are many gradations to the soft *marl*, in which I found chrystals of *spar*, and some *pyrites*, but no *marine bodies*.

93. At a little distance, a high road was carrying on upon the slope of the mountain, under the direction of M. Matthey, who led me to some parts cut to a great depth for the purpose of levelling it. Here begins a great phenomenon which

my friend Guyot had recommended to my observation, especially in the *Val de Rus:* consisting of *rounded stones*, as well primordial as calcareous, the latter differing in their nature from the *strata* of the preceding mountains. As we continued to ascend, following the brow of the precipice which rises above the bed of the *Syon*, we came to a narrow pass, forming the boundary between the territories of *Neufchatel* and *Valangin*, where M. Guyot had directed my attention to three thick *strata* of grey *lime-stone*, which are very remarkable with respect to the history of *marine animals*, and will serve as an example of what I have seen in many other places, as well in *stony* strata as in *soft*; that is to say, changes in the species of *marine bodies* in successive *strata*. In the undermost of these *strata*, which altogether form a projecting rock belonging to *Valangin*, I found no marine substances; nor did I perceive that the succeeding *stratum* contained any in its lower part; but its upper part was filled with extraneous bodies, which I can compare to nothing but the *cigarros* commonly smoked by the Spaniards, and composed of rolled up leaves of tobacco; for these bodies, in their section, appeared to be laminæ rolled up in the same manner; the largest of them were about the size of my finger in length and thickness; and they lay here in such great abundance as almost to touch each other. From these, the transition is very striking to the *marine bodies* contained in the uppermost *stratum*, of which, however, the shells are decayed, and only the nuclei

remain: they consist of *turbines* of a particular
which I had also seen in a *stratum* of the mou
of *Salève* near *Geneva*; their character is that
are flattened lengthwise, and are consequently
in their section: and here I saw among them
helices with two cingulæ, one broad and rou
the other narrow and angular.

94. Phenomena of this kind, very comm
all *stony calcareous* mountains, are so contra
the hypothesis which was first introduced by B
and has since been frequently repeated by others,
production of *calcareous strata* from the *detrit*
shells and madreporæ, that it is scarcely worth
to enter again on the subject. How could this
tus, which is supposed to have been carried alo
currents on the bottom of the sea, have been s
over tracts of such vast extent, in *strata* so regu
parallel with each other, sometimes extremely
and of a very fine grain? How should the *marine b*
contained in these *strata*, instead of exhibiting
appearance of *trituration*, preserve even their
fragile parts, as for instance, their *spiculæ?*
lastly, how should the kinds of *marine animal*
found so frequently to change in successive *st*
where it is apparent that whole *families* have
together undisturbed, since they are found of all
sometimes of a single species, sometimes of diff
species? No explanation can be given of the g
ral phenomenon, except that of which the first
was suggested by M. de Saussure, namely, a

ces

cession of *chemical precipitations* in the *primordial liquid* wherewith our whole globe was originally covered; a system which I have since extended by all my own observations. These *precipitations* were sometimes *suspended*, from a cause analogous to that which occasions suspensions during snow-storms; for they were produced in the *liquid*, as the *precipitation* of *water* is in the atmosphere, by the ascension of new ingredients under the form of *expansible fluids* proceeding from the interior part of the globe. Sometimes each repetition of these *precipitations* was of long continuance, and thus produced thick *strata;* and the suspensions being also long, time was afforded for changes in the species of *marine animals* on the same parts of the bed of the sea; at other times the precipitations were short and frequent; and in this case thin *strata* were produced. During every interruption, the surface of the *stratum* last precipitated underwent some modification, which prevented the next from uniting with it in such a manner as that the two should be consolidated in a a single *stratum;* and I have observed the same thing with respect to the snow in high mountains; in the sections of which, on the brows of rocks, after the fall of large masses, appear distinct *strata*, the product either of different winters, or of successive showers with long intervals between them.

95. From the spot which I have just described, we descended towards the small town of *Valangin*, situated at the lower end of the *Val de Rus.* This

valley is here entirely closed, except where it affords a passage to the *Seyon*, which, crossing the whole breadth of the chain by the cleft in it already described, issues forth near *Neufchatel.* Yet all this valley, and the lower part of the slopes of its mountains, are covered with an immense abundance of *blocks* and smaller masses of *rounded stones*, some of them *calcareous*, but the greater part *primordial.* M. Guyot, with the barometer, had measured the slope of the *Seyon* in this valley. At the point where it enters, above *Moulinet*, its level is 1008 feet higher than that of the *Lake of Neufchatel*; about three quarters of a league below this, its height is reduced to 840 feet; at the mill of *Engolon*, to 774; and it is only 708 at the bridge by which the river is crossed to *Valangin:* from the latter level, this stream descends into the cleft of the mountain, in its way to the *lake.* From *Moulinet* to *Valangin*, there is, as I may say, one valley within another; a *subsidence* having here taken place, of which I shall soon mention some very extraordinary characters, and which has cu longitudinally the bottom of the *Val de Rus*, leaving a terrace little interrupted, along the ridge o eminences that separates it from the *Val de l Sagne;* the mean elevation of this ridge being abou 1060 feet.

96. I have said that the bottom of this valley i covered, to a great depth, with *rounded stones* o the *primordial* classes, as well as the *calcareous*

thes

these extend also a considerable way up the foot of the mountains, especially in the part where the *Seyon* takes its passage through the cleft; and as, above this point, it forms a cascade, it has cut its way through the midst of these stones; so that its bed being for some time much below the level of the bottom of the valley, they are seen to be accumulated to a very great thickness, the *lime-stone* not yet appearing beneath them. But the most remarkable circumstance of this phenomenon is, that higher up in the valley, between *Valangin* and *Fenin*, there is, on the left bank of the river, a promontory advancing from the chain, and at some points even separated from it, though plainly appearing, when viewed at some distance, to belong to the mountain, as well as many others, within sight all the way up the valley, which is terminated by *Mont Chasseralle*, rising 3440 feet above the level of the lake of *Neufchatel;* yet the promontory whereof I am speaking is nothing but a large congeries of the above-mentioned *stones;* and its front being attacked by the river, a number of *blocks* of *granite* are seen to project in the cliff which is thus produced.

97. Here I recollected what is mentioned by M. de Saussure as an effect of the *débacle*, when, in his *Voyages dans les Alpes*, § 319, he is giving a description of some part of the borders of the *Lake of Geneva*. "Between *Tour-ronde* and *Meillerie*, the "road passes over the high hill, which extends above "*Evian*

" *Evian*.... This hill, composed entirely of gravel,
" sand, and *rounded pebbles*, and scattered with
" *blocks* of *granite* and other alpine stones, has
" been *manifestly* formed by the accumulation of
" the *deposites* of the *current*, which, at the time
" of the great *débacle*, issued from the valley of the
" *Rhone*, and rushed down into that of our *lake*."
We may here perceive the consequence of viewing certain phenomena only in some particular spots, where they are associated with circumstances, which, however striking, are often entirely accidental. If M. de Saussure had seen the above phenomenon repeated in a valley of the *Jura*, more than 1200 feet above the level of the *Lake of Geneva*, such a manner of accounting for it could never have entered his mind. Neither was I led into this error by the vicinity of the *Alps*, when I beheld the prodigious abundance of the *blocks* and *rounded stones* which are scattered in the *Val de Rus;* because, in my first travels in *Germany* I had observed the same phenomenon on extensive tracts of the country, consisting of sandy hills and plains, at a great distance from any mountain; and I hope that the very numerous facts of this kind which will be found detailed in my present travels will exclude every doubt of the expulsion of these masses from within during the catastrophes of the *strata*.

98. From *Valangin*, we ascended the terrace which follows the foot of the eminences of the right bank of the *Seyon*, and of which the level is about

350 feet above that of the bottom of the valley. We passed by *Boudeviller*, *Jonchère*, and *Haut-Genevey*, and crossed the chain of eminences separating the *Val de Rus* from the *Val de la Sagne*, at a high spot called *Les Loges sur Fontaine*, leaving on our left the great eminence distinguished by the name of *Tête de Rang*. When we had ascended above the level of the bed of *stones* which covers the *Val de Rus*, we began to see the *lime-stone strata* at the foot of the eminences; but the same *rounded stones* were still scattered on the slopes.

99. Before I quit the *Val de Rus*, I must speak of a phenomenon of the waters more remarkable than any of those which I have hitherto mentioned; and I shall give the same account of it that I received from M. Guyot: it will convey a still clearer idea of the interior state of these mountains, and will render less surprizing the phenomenon of the prodigious abundance of the *rounded stones* which cover the bottom of this low space, and even ascend the slopes of the surrounding mountains; since it will shew what passages were open to these fragments, when they were expelled from within, after having been triturated by the subsidence, the ruptures, and the angular motions of the masses of *strata*, and how violently they must have been agitated on the surface, before the equilibrium of the water and the interior air was re-established. The phenomenon now in question is an intermittent stream, called *Le torrent de St. Martin*, which

gushes out, from time to time, near the upper part of the valley: this happens most frequently after great rains, or the melting of the snows: it seldom occurs twice in the same year, and sometimes not till after an interval of six or seven years; commonly it runs only for a day; but there are instances of its continuance for four or five days: it issues from the foot of a mountain between the villages of *St. Martin* and *Dombresson.* I saw the bed of this singular stream, but it was at present dry.

100. When this torrent begins to flow, the water immediately gushes out in great abundance; for some time it continues to increase in quantity; but afterwards it diminishes, and at last ceases, till the phenomenon is renewed. The water, as it rises, bubbles out from the foot of a slope of *lime-stone* rubbish, covered with firs. The area of the space from which the torrent first issues is about 30 feet square; but many small springs appear on the course of the principal stream, and others may even be produced at pleasure within a certain extent, by perforating the turf with a stick. During the periods when the torrent does not flow, the whole of its bed is grassy; and this was its state when I saw it; when the water gushes out with violence, it carries away the turf in those particular parts; but if some years elapse without the re-appearance of the torrent, the grass again overspreads even the space from which burst forth the principal stream. The return of the *torrent* is announced to the in-

habitants of the foot of the mountain, to the distance of half a league, by the breaking out of a multitude of small springs in their grounds, and even within their houses. When the water issues forth, it soon finds its way into a channel of about five feet in breadth and depth, and not above 180 feet in length, which it has cut for itself through rubbish, and at the bottom of which it has laid open to view large masses of stones, chiefly primordial. Within a few hours after the *torrent* has begun to flow, it fills the whole of this channel, and frequently even overflows it: below its extremity, the water has no certain bed, but spreads itself over meadows and cultivated lands, till it reaches the *Seyon* at the distance of about 800 yards, preserving the whole way the utmost limpidity, though it passes over ploughed grounds, on which it does not lie long enough to set the earthy particles in motion.

101. Such is the phenomenon; and I shall now explain its probable cause in the words of M. Guyot, who gave me in writing his ideas on the subject. " Having been a witness, in the year " 1778, of three successive issues of this *torrent*, " (which was considered as a very extraordinary " circumstance,) I think I have grounds to con- " jecture that, from *Dombresson* to *Boudeviller*, " the base of the mountains, among which is *Tête* " *de rang*, covers a *subterranean river;* and that " the exterior *torrent* is formed, whenever there " is too much water in the channel of this *river* to

“ flow out, by its usual issue, with sufficient swiftness, comparatively with the quantity which enters it by several higher passages; as in consequence it then rises through crevices covered over by heaps of rubbish. With respect to the issue of this river, I suspect that, quitting the direction of the mountain below *Boudeviller*, it crosses the *Val de Rus* between that place and *Coffrane;* that afterwards, by some subterranean chasm, similar to the defile in which the *Seyon* flows above ground, it passes under *Peseux*, near the place where the latter river issues forth into the lower part of the *Val de Travers ;* and that hence it proceeds to discharge itself into the *lake* near *Serrière*, where a small stream does in fact gush out at the foot of the rocks, and is immediately employed, before it reaches the *lake*, in turning a number of wheels belonging to paper and corn mills, founderies, and large hammers moved by water. The following are the facts which have suggested to me this conjecture.

“ I. The mountain whence the *torrent* issues forms a part of a considerable mass of mountains and high vallies, of which the waters have no other discharge than by sinking into a kind of *tunnels* in the surface: these waters must therefore find within some common reservoir, and some passage by which they may be carried off.

“ II. It is well known in the country that most of the *tunnels*, which are very numerous, espe-

" cially between *Boudeviller* and *Fontaine*, retain
" the water, but at a great depth: many persons
" assure me that, when, standing near these *tunnels*,
" they have heard a noise within, like that of
" *running water;* and indeed I have heard it my-
" self near some of them.

" III. Between *Boudeviller* and *Coffrane*, there
" passes across the *Val de Rus* an *argillaceous*
" *ridge*, along which rise springs of clear water,
" cold in the midst of summer; the little river called
" *Sauge* is formed by the junction of these springs
" near *Sorgereux*, whence it flows to unite with the
" *Seyon* on *Valangin*. Now this *argillaceous ridge*
" passes in a direction towards *Peseux*, and con-
" sequently towards *Serrière* which lies below it.

" IV. Lastly, having, in 1778, at the time when
" I observed *le torrent de St. Martin* in the *Val*
" *de Rus*, made inquiries respecting the stream at
" *Serrière*, I obtained such information as cor-
" responded with my own idea. This stream is
" constantly limpid, and in common seasons there
" is little variation in the quantity of its water;
" but it swells before the bursting forth of the *tor-*
" *rent*, during the continuance of which it remains
" at the same height; but when the latter is dried
" up, the former soon returns to its usual state."

102. This deduction bears all the characters of having been made by an attentive and judicious observer; and we may take it as our certain guide to

the interior part of these mountains, where it will lead us to a knowledge of the state of such of their parts as are above the level of the Lake of *Neufchatel;* that level being the limit of all visible discharges of the waters which circulate in the interior caverns. And although this knowledge extends only to the mass of the *secondary strata,* yet from the state of these we may collect what must be that of the *primordial* beneath them; since it was the latter which first *subsided,* the edges of their separate pieces being broken and shattered in every direction during that catastrophe; and the prodigious abundance of their fragments now dispersed on the surface, intermixed with others of *lime-stone,* were then triturated and rounded by the *expansible fluids,* violently compressed in the *caverns.* In countries where the superficial *strata,* down to an unknown depth, consist entirely of *sand,* the disorder of the *stony strata* which lie under them cannot be known as it is here; but it will be seen to manifest itself by the same external symptoms, namely, *blocks* and *rounded* masses of every kind of stone.

103. From *Loges sur Fontaine,* after having crossed another ridge between two of the eminences composing it, the *Montagne du Croc* and a neighbouring mountain, we arrived at *Boinou,* which I have already mentioned as situated at the upper end of the *Val de la Sagne;* hence we passed over another ridge, and came to *La Chaux de Fond,* a large and beautiful village in the same wide *combe* in the lower

part of which stands that of *Le Locle*: *La Chaux de Fond* is 1860 feet about the level of the *Lake of Neufchatel*, and *Le Locle*, 1680. I shall not enter into a description of the beauty of the former village, where we spent the night, and where every hing bespeaks the opulence of its inhabitants in a manner which must appear very surprizing to those, who, not having heard any previous account of this place, unexpectedly come upon it amidst these wild mountains: I shall only mention that I had here the pleasure to meet with M. JAQUET DROZ, whose *astonishing* mechanical genius has so much contri*buted* to the prosperity and celebrity of this village; his automata, in particular, and those of his son, of various kinds, and reduced even to the size of ys, do honour to human ingenuity. I was no less leased with the simple manners of this extraor-nary man, than with all the products of his ta-ents which he shewed me in his work-shop; he was o good as to offer me his assistance in my obser-ations; and of this offer I availed myself in the ast of my excursions in these mountains.

May 26th. M. Matthey and his friend M. CHOUPAR undertook this morning to be my guides. We went first to the place called *Puilleret*, on the oad into *Franche-Comté*, across the ridge of emi-ences which commands the slopes towards the *Doux*. All these eminences being rounded and overed with grass, no judgment could be formed specting their interior state, were it not for another very remarkable phenomenon of the waters. On terrace at the foot of the ridge is a long row of th *tunnels* which are mentioned by M. Guyot in t foregoing account of the *torrent de St. Martin;* th are nearly equidistant from each other, like beads a rosary, and are covered with grass down to the b tom; the rain-waters descending from the mounta sink into these and disappear. Another row these *tunnels* was pointed out to me by my comp nions at the foot of a different ridge of eminenc The superficial soil being here only a very thick m of rubbish, these hollows have been formed in it the small rills, which, in rainy seasons, flow do the slopes of the mountains, and have found passa below into interior cavities. There are many mo *tunnels* of a similar kind in various parts of th mountains; and I have also seen the same phe menon in mountains composed of *primordial stra*

104. Among all the phenomena of this count the *torrent de St. Martin* is certainly that which giv us the clearest insight into those interior caver wherein the waters are collected, and where, wh too abundant to pass off freely by their usual cha nels, they rise up to the roof, and enter the crevic communicating with it; but this torrent is not t only phenomenon of its kind in these mountain M. Matthey informed me that, among the *tunne* in the vale of *Brevine*, in all of which, in commo seasons, the rain-waters are completely absorbe there are some wherein, from time to time, thoug

nothin

nothing extraordinary appears without, the water rises till it overflows; hence it is supposed that the water commonly passes off at the foot of the mountains by some issue liable to occasional obstructions, which can only be removed by the pression of larger columns of the water, when sufficiently swelled to rise to the roof of the caverns, and enter the above crevices.

105. Descending towards the valley of the *Doux* from the eminence on which *Puilleret* is situated, we passed near another grassy summit, with the prettiest village on its slope that I ever saw in any of my excursions among mountains. This village is called *Dazenet*, or *Planchettes*, is encircled with fir-woods; and the opulence of its inhabitants appears in the neatness and solidity of their houses; near it begins a *combe*, by which we went down to the bank of the *Doux*. Were any proof wanting that this river had not excavated its valley, such a proof might be found in the part of its course which we at present followed. The magnificent amphitheatre of rocks already described near *Les Brenets*, as rising in terraces covered with firs and beeches, continues here along the left bank of the *Doux;* but on the right bank there is a large tract of meadows, into which opens the above *combe*, here bordered with rocks; one of the sides of this *combe*, advancing to the bank of the river, forms a defile with the opposite bank; and it is very manifestly seen that the *combe* itself is only a greater

subsidence in the mass of the mountains; for *strata*, of which this side presents the lateral *tion*, incline strongly inwards, and rise towards channel of the *Doux*. This defile is so narrow, the stream, swelled by the late rains, entirely f it up, covering a road under the rocks, which is commonly taken to *Maison Monsieur*, a village low the defile; yet, though so much risen abov usual level, the river was perfectly clear; bec the waters that flow over the surface to join it de slopes covered with grass; and those which iss rivulets from the foot of the rocks proceed fro terior *lakes*, wherein they have deposited a earthy particles collected in their course, and w therefore they flow with the limpidity common t the rivers which issue from exterior *lakes*.

106. We took a boat to pass down the d where I observed a great change in the mo on the left: here it no longer forms a part of amphitheatre of rocks covered with trees wh have described above, and in which, large m having totally subsided, the sections of the s are seen on the sides: in this part, only a s fracture has taken place, wherein a mass of *strata* having been overturned, the side of the is formed by their *plane*, and their irregular s appears to rise in battlements on the summit of mountain; a phenomenon which M. de Sau has described on certain summits of the *Alps*.

107. Beyond this defile opens another basin of
traordinary beauty; being again a part where a
y large mass has totally *sunk*, and is covered over
h rubbish, which, having been levelled by the river,
forms fine meadows. This basin also is bor-
d by an amphitheatre of rocks in terraces, co-
d with firs and beeches; and at this season of
year, the latter, blending their new foliage of
nder green with the dusky tints of the former,
uced the most beautiful and pleasing effect. It
that the village of *Maison Monsieur* is si-
d; and a fresh symptom of great catastrophes
nts itself in a *combe*, which slopes down in this
from the top of the mountain, and by which
eascended to *La Chaux de Fond*.

May 27th. M. Matthey being obliged by busi-
to return to *Neufchatel*, M. Choupar was
ood as to stay with me, and to be this day my
le. We spent the morning in visiting the mills
h work for *La Chaux de Fond*, and which ex-
a phenomenon of the interior waters still more
rizing than any of those hitherto mentioned.
stream employed in turning these mills issues
a *tunnel* of the kind described above; after
ch, at a little distance, it runs into another, con-
ing to flow in the same manner the whole year:
r long rains, and the melting of snows, this ri-
et swells; but not nearly so much as it would do
its course were exterior throughout.

108. Though the rivulet had always flowed i
this manner, no use was made of it till the ye
1754; when the population of *La Chaux de Fo*
having very much increased, some persons of a fa
mily named PERRET thought of employing it t
turn mills; and they accordingly completed the e
terprize at their own expense, on condition that t
mills should always remain the property of them
selves and their descendants. It was easy to exc
vate a space at the entrance of the *tunnel* in wh
the water sank, and to erect a mill immediat
below its first fall; but their plan was to find pl
for a second, by continuing to open a passage al
the subterranean course of the rivulet, which l
for some way between two *strata* of very hard *lim*
stone; and they were obliged to follow it to th
length of 300 feet, before they came to a convenie
situation for another fall. After this, not knowi
what they might meet with lower down, amo
strata which were much shattered and displaced
and finding that so far there was, at each fall,
quantity of water even more than sufficient to turn
two wheels, these adventurers contented them-
selves with enlarging both their excavations so far
to place in each two wheels and two mill-stone
Then by a canal they led the overplus of the wat
remaining on the outside to a lower *tunnel*, into
which when they found that it sank, they made
there another excavation, where they placed the
wheel of a saw-mill. Such is this singular stream,
suddenly issuing forth in a high valley, (*La Chaux*

d

tered discoveries would have been of little use in
Geology, unless they had been collected, in variou
places, by attentive observers, who, at the sam
time, had laboured to discover their true connexio
with each other, and with exterior phenomen
connexions like those which subsist between t
branches springing from one common stem. I w
the more struck with what was told me by t
miller at *La Chaux de Fond*, because I was alrea
acquainted with the external state of the low hi
of *Franche-Comté*, opposite to the line of the mo
tains of the country of *Neufchatel;* and the for
exhibit, in the greatest disorder, the same *str*
of *lime-stone* which are found at the top of t
latter; thus affording an evident proof of a gr
change produced by some catastrophe in their re
tive *level.* But here two questions present the
selves: 1. Whether was this change effected
the *elevation* of the parts now *highest*, or by t
subsidence of those now *lowest?*—2. Did the cat
trophe extend no farther than to this change
relative level?—This very extensive distri
the whole surface of which, to as great a de
as it can be known, consists entirely of *lime-sto*
as well as many other countries of the same nat
both in *Europe* and in *Asia*, will immediately
solve the above questions; for these *strata*, where
they have not been broken by the catastro
themselves, form solid *tabular masses*, capab
supporting a great pressure above; which is no
case with the foliated strata, such as the

ground, gives reason to suppose that a part of them percolates to a greater depth, and that the subversion of the *strata* extends down to those of the *primordial* classes which form the basis of the rest, and of which so many fragments have been thrown out by the compressed expansible fluids. Now this agrees with what I have said respecting *earthquakes* in my *Lettres sur l'Histoire de la Terre et de l'Homme;* that, as they are not accompanied with exterior *explosions*, the *fluid* which produces them, and which shakes even the mountains, cannot be any other than the *aqueous vapour*. The *torrent de St. Martin* affords an example of what I then supposed; that the waters which circulate in galleries above those wherein *lavas* are formed, in the common course of things, find free issues; but when, in consequence either of some obstacle in their course, or of some increase in their volume, they rise in these channels, they then meet with crevices through which they penetrate down to the furnaces where the *lavas* are prepared. Among physical causes, there is no one that possesses a power equal to that which may be exercised by the *aqueous vapour* produced in these subterranean furnaces, while it subsists with the same degree of density; as is the case so long as it only extends itself along the deep galleries in which the matter of the *lavas* is formed by a kind of combustion; but when at last this vapour enters higher passages, where it no longer finds an equal degree of heat, it is decomposed, and thus loses its force. This theory is supported by all the phenomena of *volcanos;* and *earthquakes* themselves afford a proof that the catastrophes of the *strata* have been produced by *subsidences;* for if the stability of our *continents* is not destroyed even by a force capable of shaking the mountains, it is because the large and disunited masses that compose them rest on the bottom of the *caverns* into which they have sunk, such subterranean passages only, as I have just described, remaining between them; so that, ever since our continents have existed, no farther *subsidences* have taken place, except, a few of a local nature, like that which has produced the *lake of Etalières.*

113. With respect to the second question, namely, whether the catastrophes have been confined to the change of *relative level* in the masses of *strata* now forming *low grounds* around mountains, the *caverns* which I have described in the latter, together with the *angular motions* which I have shewn to have been undergone by most of the masses that compose them, prove that, besides *relative differences,* a general *subsidence* of the whole crust of the *strata* has taken place, most probably at different periods, but always beneath the waters of the sea: and this I have demonstrated by many characteristic phenomena,

114. Observing that, in the mills of *La Chaux de Fond,* the mill-stone swere of *granite,* I inquired of the miller whence they had been brought; he told

me that stones of the same kind abounded on every part of these mountains, where they were known by the name of *grisons*, as being distinguished at a distance from the grass of the grey lichens with which they were incrusted; but that those of a sufficient size to be cut into mill-stones were chiefly found on the side of the ridge descending towards the *Doux*, in the lower part of the *combe* near *Dazenet*, known by the name of the *Plain de Peseux*. In the stone fences also, which are built of the stones scattered over the downs, or turned up by the plough in the cultivated parts, I saw *primordial* fragments mixed with those of *lime-stone*.

115. In the afternoon, M. Choupar and M. Jaquet Droz were so good as to conduct me to a *marl-pit* lately opened on these eminences, the *marl* lying here also under the same yellowish *lime-stone* as on the opposite slopes of these mountains; which affords another proof that all these *strata* have participated in the same catastrophes. In our ascent from *La Chaux de Fond*, we passed over the point of junction of two ridges of eminences diverging hence to border the higher part of the *Val St. Imier*, a low tract which I observed the following day. At this point I found *blocks* and smaller fragments of *primordial stones;* and it commands, on the opposite sides, very different prospects: we had ascended to it over the commons belonging to *La Chaux de Fond*, which rise in a gentle slope; while the side towards the *Val St. Imier* is a rapid declivity

strata and their *rubbish*, the whole of which, on these mountains, is hidden by the grass.

May 28*th*. I set out this morning from *La Chaux de Fond*, for *Ferrière d'Arguel*, the residence of Dr. Gagnebin, a physician, whose collection of the fossils of the *Jura* was much celebrated in this country: hence I meant to proceed to the *Val St. Imier*, which M. Guyot had particularly advised me to observe throughout its whole length; and having mentioned my plan to M. Jaquet Droz, he was so good as to accompany me in the first part of my way.

117. We ascended from *La Chaux de Fond*, following the ridge of eminences which borders the extremity of the *Val St. Imier;* and on the highest part of this ridge, beyond the boundary separating the countries of *Neufchatel* and *Valangin* from the Bishopric of *Basle*, is *Ferrière d'Arguel*, situated at the height of 2100 feet above the *lake of Neufchatel*. We went immediately to the house of Dr. Gagnebin, whom I had great satisfaction in seeing: with this old gentleman I conversed on the subject of my observations in countries so perfectly known to him; and he had the goodness to shew me his collection of marine fossils, the varieties of which were very interesting. Amongst the rest, I saw a specimen very generally celebrated, having been engraved in Bourguet's work, and in the

Acta Helvetica; this is a *star-fish* with five rays, perfectly well preserved, on a splinter of *grey limestone,* found in the Doctor's own field.

118. There is a way down almost immediately from *Ferrière* into the *Val St. Imier,* by a passage across the ridge of eminences which borders the latter; and these gentlemen having given me the necessary directions, I took leave of them, and set out. On quitting *Ferrière,* my prospect in front was entirely bounded by the above ridge, which is much intersected; but when I had crossed its summit, I was very much struck with the view that opened before me. I here looked down into a very low *valley,* terminating at both ends in a *cul de sac,* the end nearest to me being that at which is situated the village of *Les Convers,* where I had been the day before. The sides of this valley are crowned with eminences, forming a kind of scalloped outline; and their rapid slopes, studded with projecting rocks, are covered with fir trees. Along the foot of both these sides are *terraces* overspread with rubbish, well cultivated, and very fertile; and the bottom of the *valley,* varying in breadth, consists of meadows, through which winds the *Suze.* But these are not the only circumstances in contradiction to the hypothesis of the *excavation* of *vallies* by *running waters;* it will presently be seen in what manner the *Suze* is formed, and how it issues from this low space.

119. From the point where I had crossed the ridge of eminences, I went down, by a very steep path to *Renans*, the highest of the villages properly within the valley, being the nearest to the *cul-de-sac*, on an elevated part of which is the village of *Les Convers*. *Renans* is no more than 1200 feet above the level of the *lake of Neufchatel;* so that I had rapidly descended 900 feet. *Mont Chasseral*, which is the highest of the summits in this part of the mountains, and has an elevation of 3440 feet, belongs to a ridge, on the opposite side of the valley, consisting of many eminences one behind another. Wherever I could discover the *strata*, either on the summits or in the slopes, I saw them inclining towards the valley; these strata also have slipped in masses one over another, and thus form irregular steps. The greater part of the waters which fall into the *Suze* are *rivulets* issuing from the foot of the rocks on the sides of this sunken space; in descending the left bank of the river, I passed successively through the villages of *Sonvillier*, *St. Imier*, *Vilaret*, and *Cormoret;* it is between the two latter that the *Suze* receives the first stream, not to mention mere springs; this issues from the foot of the mountain, and bears, in its short course, the name of *Doux:* a little below is the source of a large rivulet; and another, still more considerable, bursts forth from between the rocks in the midst of the village of *Cormoret*, very near the *Suze*. Continuing to descend the course of the river on the same side, I came to the villages of *Courtelari*, *Cortebert*,

tebert, and *Corgemont*; opposite to the latter, on the right bank, a stream, which is sufficiently large to be called a *small river*, issues, in the same manner, from the foot of the rocks; and the *Suze*, after having received it, becoming of considerable size, flows on to *Sonceboz*. Here the valley terminates in another *cul de sac*, perfectly similar to that above *Renans* at its upper extremity; and by what kind of passage the river continues its course will appear in the sequel.

120. As it is only to the phenomena of the *waters* that I am here attending, it may be seen that the correspondence of their indications respecting the *interior* part of the *mountains*, with the *exterior* state of those eminences, confirms my opinion already expressed, that the *mountains* themselves are masses of *strata*, which, having *subsided* from a higher level, were broken in such a manner as to have fallen in the greatest confusion on the bottom of the caverns whence these catastrophes resulted. It is only, as I have explained, in the *strata* of *limestone*, and probably, for the same reason, in those of *granite*, the lowermost of all, that the masses subsiding in this disorder have left the numerous subterranean passages, which are manifested by the *waters* down to the level of the low *vallies*, and by *earthquakes* throughout the whole mass of the *continents*.

121. I proceeded no farther this day than *Sonceboz*, at the lower extremity of the *Val St. Imier.* This valley is really a store-house of *primordial stones:* it is in a direction towards the *Alps*, but is entirely closed at the end nearest to those mountains: as I approached that spot, I discovered, at a considerable height, two clefts in the rocks on the opposite sides of the *cul de sac;* but I did not yet perceive what became of the river.

May 29th. I went up this morning to the cleft on the left side, in which there is the high passage called *Pierre Pertuis*, forming the communication between the *Val St. Imier*, and the *Val de Tavanne.* To this opening I ascended by a *combe*, at first narrow, but afterwards wider, and leading up to a high *terrace* which borders the *cul de sac* of *Sonceboz.* From this terrace I continued my ascent by a fracture in the mountain, becoming gradually so narrow as barely to afford space for the road: the soil here consists entirely of fragments of *primordial stones* intermixed with those of *lime-stone;* and I saw a fine *block* of *serpentine* among others of *granite.* When I came to the bare rocks which rise above this slope, I found their *strata* in the greatest disorder: for in some, the *lines* of the separation of the *strata* are *horizontal*, in others *vertical;* and the *sections* of the latter, which are the points where they have been broken off, form the summits, as well of the rocks above, as of those projecting on the slopes: the upper strata incline towards the *Val de Tavanne.* The fracture in these rocks, though accompanied with the retreat of the sides, presented at first no passage, because a large tabular mass had fallen down across it. This is the mass which is now called *Pierre Pertuis,* it having been long since cut through, in the form of a gate-way, as is supposed, by the Romans; and the traces of an inscription may still be seen on it.

122. I descended through this opening into the *Val de Tavanne,* in order to examine on that side the foot of the ridge of eminences by which it is separated from the *Val St. Imier;* and here also I saw large rivulets gushing out from the rocks, and forming by their junction the *Doux de Tavanne,* a small river so called because it passes by the town of *Tavanne,* from which the valley likewise derives its name. This stream is the most remote of those that unite to form the *Bisse;* and the latter, flowing from valley to valley till it arrives at *Basle,* there discharges itself into the *Rhine.* I have now mentioned three streams in this country, all bearing the name of *Doux,* which therefore appears to be an ancient generic term for a *river.* Other generic words are used in the same sense along the *Alps,* in *Provence, Savoy,* and *Piedmont;* these are *Drance* in the first country, *Nant* in the second, and *Doire* in the third; some distinctive epithet being always added to denote the particular *stream.* These words are probably Celtic; for my nephew met with some of

them

the opposite side, the air, where enlightened by its rays, formed a bright line, which seemed to intersect the mountain from top to bottom, and which, as the firs were now in shade, was very distinctly seen betwixt them. The cleft that was indicated by this line is so narrow at the bottom, that it appears but just wide enough to admit the *Suze*, which, on its entrance, falls from rock to rock on its steep and irregular bed: a road has been cut on one side, and follows the river with less declivity. Afterwards this passage widens; there is even, in the mountains on the right, a large recess of a form similar to those already described in the *Val de Travers*, and here are seen the *sections* of the *strata* strongly inclined towards the basin from which the stream has just issued, and in which the greatest *subsidence* has taken place. In this wide part is the village of *Ruchenette* where the *Suze* is employed in moving heavy hammers.

126. Below this first cavity, the *defile* suddenly turns behind that part of the mountains which, in my way hither, I had passed on the left; and the *strata* are here seen in their lateral *sections* to incline the same way as the preceding, that is to say, towards the large basin. The *Suze* continues to flow at the bottom of this long winding fracture, where it is confined the whole way in a narrow channel, though in many places the higher parts of the rocks retire, and leave several successive wide openings: I followed the direction of the river on a terrace above,

where I often lost sight of it, on account of the depth at which it flowed: whenever it was within my view, I saw it forming many cascades among rocks, the latter being undoubtedly masses that had subsided during the catastrophe which occasioned the disruption of the strata: that these masses are not put in motion by the stream is shewn by the usual proof; they are covered with *moss* wherever the water passes over them; and at the discharge of the river into the *Lake of Bienne*, where I again met with it, may evidently be seen that it has not brought any of them down from the mountains; for it has deposited nothing in that spot except sand and small gravel.

127. In describing the abrupt sides both in and below the *Val St. Imier*, I have not spoken of the *chronometer* which is afforded here, as it generally is among all mountains, by the *slopes* of *rubbish* successively formed at various heights, wherever this *rubbish* is retained on lower terraces. I have already remarked in § 26, on entering this mountainous tract from *Franche Comté*, that, if our *continents* had been of very great antiquity, all abrupt sides would have ceased to crumble down, and the *slopes* of *rubbish* would every where be covered with trees, bushes, or grass, according to their nature, as they already are in a great many places; but that in some parts, the *slopes* not having yet risen to a sufficient height, the crumblings down are still too frequent to allow plants to grow

on them; and of both these cases I found example in the road which I have just described. Her most of the *slopes* of *rubbish* are covered with fi woods; and wherever the trees have grown to th height of the rocks, still remaining abrupt behin them, the latter, in consequence of the shade an moisture, are overspread with moss, and the operation is at an end; but some of the slopes ar still naked, because vegetation is disturbed on them by the frequent falls of fresh rubbish from abov Paths have been made on these slopes by the wood cutters; and the trees, when felled, are either caused to slide down the snow in winter, in tracks cut fo that purpose, or else are thrown from terrace to terrace. The industry and good sense which are shewn by the mountaineers in some parts of these labours have often excited my astonishment.

128. On the bottom of the last of the spaces enclosed within these mountains, which, at its entrance, appears another *cul de sac*, I again found no *primordial stones;* but on the heights, the case is otherwise. In this space, the *strata* assume a different inclination, and dip towards the outer side of the eminences that bound the view: its issue much resembles that of the *Val St. Imier;* the river finds a passage through a large fracture, by which the mountain on the right is cloven from top to bottom: I ascended this mountain towards a narrow pass at a considerable height; and before I reached it, I saw some large *blocks* of *granite* on the slope;

but after I had passed through it to a *terrace* of small breadth, formed by the upper section of a large *tabula* descending rapidly towards the plain at the extremity of the *Lake of Bienne*, I saw on this terrace, at some distance on the left, a heap of blocks of the same kind, which seemed to have been collected together for some particular purpose. These *blocks* were as large as the huts of the mountain shepherds; and on approaching them, I perceived that they were lying on the indented sections of dipping strata, the points of which, beneath the higher part of the mountain whence they had been detached, appeared among the *blocks*. Hence I saw, but at a great distance, the snowy or central chain of the *Alps*, being that in which *granite* is found; but if, notwithstanding the distance, and all the exterior ridges composed of *secondary strata*, it were possible to suppose that blocks detached from that chain could have reached the foot of the mountains of which I am now speaking, still by what agent could they have been lifted up and laid on this high *terrace?* Besides, it will presently be seen of what the low grounds consist.

129. I descended from this terrace by a road cut aslant on the slope, into the space extending from the chain of the *Jura* towards that of the *Alps*; and though, from above, this space had appeared a *plain*, I now found it to be interspersed with *hills* formed by the summits of masses of *lime-stone strata*, which, originally continuous with those of the neigh-

bouring mountains, have here sunk in the greatest disorder; and particularly on the southern side, where their subsidence has produced the *Lake of Bienne*. I soon lost sight of the *Alps*; for the first ridge of these hills which presented itself before me, and which, from above, I had scarcely remarked, concealed from me all that lay behind it: this ridge, retiring, forms the eastern border of the *lake*, evidently much shortened at this extremity, as well as at that near the *Lake of Neufchatel*, by the sediments of the waters which descend from the mountains. To this effect, the *Suze* has here greatly contributed; I passed before the fracture whence it issues, and where, when the lake came up to that point, the stream deposited all the materials which it had been able to collect either in the *Val St. Imier*, in the large basins of *Hutte* and *Ruchenette*, or in the three long *defiles* described above: now all these materials are here seen to consist merely of small gravel and minute particles, which are still continuing to accumulate, and to encroach more and more upon the *lake*. It is through this alluvial soil, that the *lakes* both of *Neufchatel* and of *Bienne* discharge themselves in a stream, which, having joined the *Aar*, proceeds with it to fall into the *Rhine*.

130. When I had reached the *lake*, I followed its western border along the foot of the mountains. I do not believe that any man who should take this road, however he might be prepossessed with

contrary opinions, could close his eyes against the conviction that the whole of the wide valley occupied by this lake and that of *Neufchatel* is the effect of a vast *subsidence*, comprizing not only the large mass of *strata* which forms the bottom of the lake, but likewise all the other masses, which having suffered great angular movements, are now remaining at a higher level; on the opposite side in simple *hills*, but in mountains on that which I followed, and on which, all along the *lake*, there are large *tabulæ* in a line with that one whence I had descended by an oblique road; these *tabulæ* rise to a great height; and at their foot I saw fragments of others which had slipped down lower, and which it has been necessary to cut away in some parts to make the road; and here it is not requisite to go very far in search of an aperture whereby the blocks of *primordial stones* scattered in great abundance on the borders of the lake may have been thrown out from within; for all these tabulæ are fractured, and in many parts their fractures have continued open. These *blocks* are also found along all the borders of the *Lake of Neufchatel;* and the same phenomenon has been described by M. de Saussure on those of the *Lake of Geneva.* I spent the night at *Neuville*, near the south-west extremity of the *Lake of Bienne.*

May 30th. In my way from *Neuville* to *Neufchatel*, when I came to the middle of the interval between the two *lakes*, I remarked that against this part of the foot of the mountain there were no *tabulæ;* for they had here slipped down beneath the level of this low space, which, to a great extent, has all the appearance of having been filled up with the sediments deposited by the waters descending from the mountains and hills, and by the waves of the two *lakes,* which originally formed but one; this was M. de Saussure's opinion as well as my own, and it is likewise that of the inhabitants: from the same causes, the marshes at the other extremity of the *Lake of Neufchatel,* where the town of *Iverdun* is situated, are also continuing to extend themselves.

131. The lateral sections of the *tabulæ* leaning against the foot of the mountain appear at each extremity of the interval in which, as I have said, they are interrupted: I described, in § 89, those on the side next *Neufchatel,* where there are three of them, one above another, with longitudinal dales between them; but on the side next *Neuville* I saw but one *tabulæ,* which rises to a great height, and behind which there is likewise a high valley. The intermediate part of the foot of the mountain is covered by a slope composed of fragments, mostly rounded, like those of the *Val de Rus;* this slope extends down to the road from *Neuville* to *Neufchatel,* and the fragments consist both of *primordial stones* and of *lime-stone.* On this slope, a road has been cut up to the vale above, through which lies the way to *Mont Chasseralle.*

May 31*st*. M. DARDEL, a clergyman, one of the gentlemen to whom my friend Guyot had recommended me at *Neufchatel*, was this day so good as to accompany me to the *marl-pits* of *Haute-rive* and *St. Blaise*, situated near the eastern extremity of the *Lake of Neufchatel*, on the left bank of the stream by which this lake discharges itself into that of *Bienne*, and which is crossed by the bridge of *Tiele*.

132. Along this side of the mountains, it is considered as a general rule, that the entrance of the *marl-pits* is always to the *north*; which, however, means only that it turns towards the *mountains*. Throughout this whole space, the *strata* of yellowish *lime-stone*, and of the *marl* alternating with it, were the *precipitations* of the sea during a long period; and those of *lime-stone* being the last formed here, they consequently lay above all the rest. Now in the great *subsidence* from which resulted the low *vallies* and the basins of the *lakes*, besides the principal *fracture* whereby the parts thus subsiding were detached from the great mass now forming the *mountain*, many other fractures, irregularly parallel with the first, divided the falling masses into several ridges, which, inclining towards the point of the greatest *subsidence*, were retained at different levels on the borders of the interior *caverns*; and as, when these masses separated in the parts where the *strata* of *marl* lay between those of *lime-stone*, the uppermost pieces slipped down to the greatest depth, the

sections of all these strata are found to be turned towards the mountain, that is to say, towards the principal mass, from which they were broken off. I have shewn, in the neighbourhood of *La Chaux de Fond*, that some of these masses, containing *strata* of *lime-stone* and of *marl*, have remained at the top of the mountains, while others, on the contrary, have fallen down to their foot; the latter is the case with respect to the marl-pit of *St. Blaise*, it being but little above the level of the *lake*. Lastly, wherever any of these mixed masses, having fallen from above, and finding support on the brink of the great subsidence which has formed the cavity of the *lake*, have assumed such a position as that their *strata* have become *vertical*, the *section* of those of *marl* is at the surface, where it is covered only by fragments; and this is the case in the *marl-pits* which I first described at *Gorgier* and *Belle-vue*, on the same side of the *lake*. I had been told by my friend Guyot, and it was confirmed to me by M. Dardel, that the greatest variety of *marine-bodies* was found in the *marl* of those *strata* which, having been originally at the highest level, had consequently fallen the farthest forward at the foot of the mountains; I had seen that this was the case in the above two places; and I again observed it in the marl-pits of *St. Blaise*, as well as in a higher mass at *Haute-rive*.

133. This phenomenon of large masses of *strata* which, having been detached from those remaining

at a higher level under the form of *mountains*, now incline towards the *cavities* of *lakes*, is particularly interesting, because it shews the mistake of those who pretend that these *cavities* have not resulted from any of the causes which effected the subversion of all the *strata* before the birth of the *continents*. But as the basins of *lakes* are only the lowest parts of *vallies* and *plains*, which were certainly produced by the catastrophes of that period, and as this phenomenon, characteristic of *subsidence*, is found on the borders of the *plains* as well as of the *vallies*, the hypothesis that the latter have been *excavated* by *running waters* is thus overthrown. Of this fact, I have already given examples from the descriptions of M. de Saussure, among which, in § 167 of my *Elementary Treatise on Geology*, I have particularly cited that of the great valley of *Faucigny* in the *Alps*; I have myself described the same phenomenon in the *Val de Travers*, and the adjacent parts belonging to the *Jura*; and I shall now adduce an instance of it on the borders of a plain.

134. I always communicated my principal observations during my travels to my brother: and on my describing to him the large masses of *strata* leaning against the foot of the mountains by the side of the *lakes* of *Neufchatel* and *Bienne*, he recollected some rocks which we had formerly viewed together along the foot of a part of *Mont-Salève*, on the borders of a plain separating that mountain from the chain of the *Jura*, between *Geneva* and

Fort de l'Ecluse; and he went to examine them again with his eldest son, many of whose observations I have introduced into my travels in *England.* The side which *Mont Salève* presents to this plain is abruptly cut down, the whole way from the top, to the *slope* of *rubbish* accumulated at its foot. A fracture, forming the narrow *defile* wherein the village of *Monetier* is situated divides this mountain into two parts, which are called the *Grand* and the *Petit Salève.* It is by the greater *subsidence* of the mass of *strata* now composing the *Petit Salève,* and their *inclination* towards the valley of the *Arve,* that the above interval has been produced: this is evident at the first view; because in the *Grand Salève,* the lines of the *strata* on the side towards the plain are nearly *horizontal,* while, in the *Petit Salève,* the *inclination* of these lines follows the direction of the summit, which descends towards the *Arve.* Besides, my brother and I found on the slope of the *Grand Salève,* towards *Monetier,* at a level 4 or 500 feet above the highest part of the *Petit Salève,* the same *strata* which are at the summit of the latter, and which are easily known, as well by their nature, as because they contain a great abundance of small *echinites spatangi,* whereof there are none in the lower *strata* of the *Grand Salève.*

135. This whole assemblage of circumstances manifestly indicates the nature of the catastrophes which have happened in this place. Besides the

great *subsidence* whence have resulted the *plain* and the *abrupt side* of both the *Salèves*, these two eminences have been separated from each other by one principal *fracture;* and the mass of the *Petit Salève* sinking to a greater depth, and assuming a stronger inclination, the interval in which *Monetier* is situated has thus been produced. But that same *abrupt side* shews many other symptoms of the catastrophe; it is everywhere full of fractures and crevices; so that not only it is constantly crumbling down, but large masses are frequently detached from it: one of these happened to fall, as I was going up towards *Monetier* once in the dusk of the evening; and seeing it bound down the slope among the brush-wood, I took it for a wolf coming towards me: having in my hand a stick pointed with iron, I turned to meet it; when, very fortunately, this imaginary wolf, being repelled by a sharp projection in the rock, flew up over my head, and I afterwards saw it bound as before down to the foot of the mountain, where it was stopped by a ridge of large blocks of the same kind, some of which had rolled to a considerable distance. The fragments are already accumulated to a great height against this *abrupt side;* but they have not yet entirely concealed the original state of its foot; a succession of rocks, nearly on the same line, still rises above the *slope:* these were the rocks which my brother and my nephew went to observe, and which they found to consist of the upper extremities of masses of *strata*, forming a single large *tabula*

sinking

sinking beneath the soil of the plain. Here, ı also along the mountains of *Neufchatel,* th *tabulæ,* inclined and passing under the soil at th foot, are like the direction-posts erected by road-si to point out the situation of particular places. I the inclination of these *tabulæ,* even below the surfa shew what is become of the large masses wh originally filled up the vacancies now forming *val* and *plains.* I have described these cases thus p ticularly, because they furnish examples of what very frequently found along the sides of mountai and I have shewn the conclusions which may drawn from them, in order to fix the attention those who may elsewhere meet with phenomena the same kind.

June 3rd. Not having sufficiently examined t spot where the *Seyon* issues from the *Val de Rus* little above *Neufchatel,* I devoted a part of this d to that purpose.

136. I have already said that, at the lower e tremity of the *Val de Rus,* the *Seyon* rushes into deep cleft, which passes across the mountain, a opens near *Neufchatel.* This cleft intersects fr top to bottom the lowest and most projecting of t three *tabulæ,* here rising one above another, a forming the front of the mountain: below the cas of *Neufchatel,* the cleft is abrupt; and within certain extent, the lateral section of the *tabula* covered with a slope composed of fragments.

one spot, where I stood about 60 feet above the bed of the *Seyon*, I saw the section of the strata of *marl* under those of yellowish *lime-stone;* and here I distinguished some greyish *strata*, which formed the transition from the *lime-stone* to the bluish *marl*, being softer than the former, and harder than the latter: I perceived in all of them the same *marine bodies*, and in the marl I saw a beautiful *mother-of-pearl nautilus;* but it was not within my reach. On the bed of the *Seyon* were many of those rounded *primordial stones* which I had seen in the *Val de Ruz*, whence this river proceeds, and which, in its inundations, it had washed down the rapid slope.

June 4th. I spent part of this day with M. BOSSET-SANDOZ, at his beautiful villa called *La Rochette*, situated in the upper part of the vineyards, above the suburb of *Neufchatel*, to which I had ascended on a former day.

187. Being desirous, in my conversation with this gentleman, to gain information respecting the phenomena of the country, I took occasion to introduce the subject of the masses of *primordial stones* which are scattered here in such great abundance; I found that M. Bosset himself considered this as a very surprizing phenomenon; he told me of many remarkable circumstances that he had observed to attend it on the mountain of *Chaumont*, a high terrace above the three *tabulæ* already described, where he had a farm house; and as I ex-

pressed

pressed a desire to visit this spot, he took me thither in the afternoon. According to the measurement of M. Guyot, the summit of the *Chaumont* is 1220 feet, and this farm-house 1760, above the level of the *Lake of Neufchatel.* The following were the circumstances which had been observed here by M. Bosset.—1. Such *blocks* as are not buried in the soil, have always their broadest side resting on the ground.—2. Wherever the *strata* of *lime-stone* are covered with *rubbish,* it is on the latter that the blocks lie.—3. *Broken blocks* are often found, the separated pieces of which, lying near together, present towards each other the corresponding parts of their fractures; whence it has been fancied that they might have fallen on our globe in consequence of the destruction of some *comet.*—4. Besides the *blocks* of *granite,* there are some of many other kinds of *primordial stones,* with abundance of scattered fragments, among which are found prisms of *rock crystal:* M. Bosset was so good as to give me one of these prisms, about two inches in length and one in thickness, and in colour of a kind of purplish grey. In our cabinet at *Geneva,* we have several similar crystals which were found on the hills of *Burgundy;* and as I have had opportunities in *London* of seeing a proof that the same phenomenon exists likewise in *South America,* it is hence very evident that all these *stones,* foreign to the soils whereon they lie, are to be ascribed to the catastrophes of the *strata.* The *Brazil pebbles,* as they are called, of which many are brought to *England* and cut for spectacle glasses and other purposes, and which appear to be only *rounded stones*, like those found of *granite*, *porphyry*, and other genera, are really fragments of *prisms* of *rock crystal;* on examining a great number of them, I perceived this very plainly; and I saw in one particular, many inches in thickness, which retained its pyramid at the top, and of which the angles were but little worn by friction.

138. In the hills and plains that occupy the space between the *Jura* and the *Alps*, there are *strata* of a different kind, which I have not mentioned here, because, in this journey, I did not meet with them; I have observed them however in many places; but they are so exactly described by M. de Saussure, especially in the 1st Vol. of his Travels, that I do not think it necessary to give more than a very brief account of them. These *strata* consist of *sand-stone;* on the spot, they are called *molasse*, when they are soft, and *grès*, when they are hard and of a finer grain. When the base of these *sandy strata* is attained, they are always found to cover *lime-stone:* the lowermost of them is commonly a kind of *breccia*, containing *fragments* of all the *strata*, which lie beneath it, *primordial* as well as *calcareous;* of these *fragments* some are angular, but most are rounded: and all the upper *strata* consist entirely of pure *sand*, indurated by a *calcareous gluten*. These *strata* have participated with

those below them in their latest catastrophe which the masses separated by fractures under *subsidences* and *angular movements:* their u sections form the bottom of the *Lake of Genev* those parts where it is bordered by hills of same species. Moreover, it was in these l catastrophes that the *blocks* and *gravels* of *pri dial stones* were expelled from within; for the scattered over these hills composed of *sand-s* in the same manner as I have described on mountains of *lime-stone*.

June 8th. I set out from *Neufchatel* on m turn to *Paris*. Since the 2nd of May, the da my arrival in the *Val de Travers*, I had trav entirely on foot, both on account of the natur the roads, and because it is impossible to obs mountains with sufficient exactness, without b at liberty to ascend to such parts as are often very ficult of access. But now, being acquainted the road by which I was to return, and having longed my absence beyond the time that I had posed, I travelled post, without stopping in night; however, during the day I continued observe the objects which presented themselves the road.

139. When I came to the mountain of *La C sette*, which nearly closes the *Val de Travers* at end next *Neufchatel*, I found that the road cu the rocks was at present impassable, becaus

quar

quantity of fragments had crumbled down on it from the kind of roof above, and several men were therefore at work in repairing it; I was consequently obliged to pass under the rocks, through a piece of ground called *Champ des Moulins*, which is properly only a wider part of the bed of the *Reuse*, and from which I afterwards ascended by a very rough way into the great road beyond *La Clussette*. It would be very difficult to give an exact description of the *strata* in this low space, as in their fall they have been broken and overturned in such a manner, that their masses, at various points, rest one against another: those which are under the projecting rock of *La Clussette* descend rapidly towards the sunken space; and it is this that renders it so difficult to maintain a road here; because the rubbish falling from above slides down the plane of the *strata*, and falls into the *Reuse*, which, during floods, carries it down lower, and spreads it over all the wider parts of its bed, such as the *Champs des Moulins*.

140. The complex nature of the catastrophe which produced the disorder of the *strata* in this spot, opposite to the great cavity of the *Creux du Vent*, shewed itself very evidently when I had returned to the road above *La Clussette;* for the *strata* have here an inclination contrary to that of those on the other side of this mountain, and descend towards its interior part, turning their *section* to the same point to which the latter present their *planes*. It is not

surprizing therefore that, around this spot where the great *subsidence* of the *strata* took place, masses of *primordial strata* have been thrown out by the expansible fluids in very great abundance. The bed of the *Reuse* might here be taken for that of a torrent in the central chain of the *Alps;* and as, in my ascent from it, I observed the *blocks* scattered on the slope, I saw a phenomenon of the kind pointed out to me by M. Bosset on the *Chaumont,* one of the largest being broken into two pieces, which lay at some distance, but presented towards each other those sides where the fracture had taken place; a circumstance not explicable otherwise than by supposing them to have *fallen* from a height to which they had been thrown by an explosion.

141. From these mountains I entered *Franche-Comté* by the great cleft already described, within which the *Chateau de Joux* stands on an insulated rock. If attention is here paid to the low ground over which the road passes after descending from the mountains, it may easily be seen to resemble the summits of the latter in the nature of its *strata;* only that in this part the *strata* are more shattered, and are covered with a greater quantity of rubbish. I next came to the *Doux*, running in a wide and nearly horizontal valley, which it overflows in the rainy seasons, and when the snows are melted; this space precedes that wherein the river flows at the foot of the mountains of *Neufchatel;* and on the part of its bed which was not covered by

the water, I saw fragments of *primordial stones* intermixed with others of *lime-stone.*

June 9th. The hills rise at *Pontarlier,* where they still consist of *strata* of *lime-stone;* they have a superficial soil of rubbish, which is cultivated, and in most places renders it impossible to discover the situation of the *strata;* here and there, however, the latter appear in projecting rocks and in abrupt sections on the sides of the hills; and they are frequently perceived to be nearly *vertical.* Here I saw *blocks* of *primordial stones* on the summits as well as in the vales. In a large space which extends from *La Maison neuve* to *L'Hôpital de Grands Bois,* the surface is formed by the upper *section* of the *strata,* dipping inwards, as has been seen on some summits of the *Jura.*

142. After leaving *l'Hôpital,* I passed over a ridge of hills, from which I afterwards descended towards *Besançon,* by a road cut down the steep side of one of them. In this descent, I saw the *section* of the *strata* in some projecting rocks; they incline into the interior part of the hill, and rise towards the vacant space which has been produced by a greater *subsidence.* The *Doux,* after having flowed from valley to valley, along the foot of the mountains of *Neufchatel,* and passed through the defiles wherein I have described it, suddenly turns back through other vallies, and pursues its course to *Besançon,* where it flows round a promontory of

which both the sides are abrupt, and on which the citadel stands: the sides of the surrounding hills have likewise been left abrupt by the same subsidence.

143. The hills, still composed of *strata* of *limestone*, become gradually lower beyond *Besançon*, and at last sink into plains interspersed with small eminences; these are all cultivated on a soil of rubbish, which in most parts conceals the state of the *strata*; but here also some abrupt clefts occasionally occur, where the strata are seen in great disorder; and *caverns* even have been discovered near *St. Witt*, where they extend beneath the soil. Between *St. Witt* and *Orchamp*, I saw abundance of fragments of *primordial stones* among the superficial rubbish.

144. I said before that M. de Saussure had made the same remark with myself respecting the identity of the *strata* in the plains of *Burgundy* and in the *Jura*; but his observations had been confined to a particular road. Of the plains extending from *Besançon* to *Dole*, he speaks in the following manner: (Voyages, § 345.) " The *strata* which constitute " the base of these *plains* appear the continuation " of those of the *Jura*; their intrinsic nature, their " colour, the fossils found in them, are the same " as in the small hills terminating that chain .... " (§ 346.) The hills gradually sink into these " *plains*, which have for their base strata *perfectly*

"*horizontal* of the same nature as those of the "*Jura*, and formerly, perhaps, entirely *continuous* "with them." Of this original *continuity* no doubt can be entertained, after observing the identity of the *strata*, though at levels so different; in some of these plains, moreover, only a simple *subsidence* has taken place, so that the strata are there *horizontal*, of which I shall presently give an example; but in most places the sunken masses have undergone *angular movements*, even below the level of the plains; as appears from the *caverns* near *St. Witt*.

145. The chain of the highest eminences of the *Jura* terminates abruptly towards the valley of *Pontarlier:* they are bordered by some large masses, which, having been retained, during the subsidence, at a higher level than the rest, form irregular *hills*, where, in many of their steep sides, the *strata* are seen to be strongly inclined: in some *plains* below these, (probably the plains of which M. de Saussure speaks,) the same *strata* are really *horizontal;* but they have been shattered in their fall. From *Dole* to *Dijon*, the subsidence has been still greater; and the surface being at the level of the springs which proceed from the higher grounds, very extensive meadows have been formed here; but this lower space bears also the character of an irregular *subsidence;* for there are some parts which rise above the level of the meadows, and which, being covered with rubbish, are in tillage. In one of these pieces of ground, above the level of the meadows, I saw that the

surface was formed, in some places by the upper section of the *strata* strongly inclining inwards.

June 10*th* to 12*th*. From *Dijon*, the same *lime-stone strata* extend by *Villeneuve* and *Monbar* as far as *Joigny;* they bear throughout the same symptoms of catastrophes, forming *hills* intersected by *vales;* the hills frequently presenting *abrupt sides* towards the parts where the greatest subsidences have taken place. Moreover, the effects of time are everywhere visible in the *slopes* of *rubbish* under the rocks; for some of these slopes are entirely overspread by vegetation, while others are more or less bare, because, as the rocks rise to a greater height above them, they are still occasionally subject to be covered by fresh falls of loose materials. From *Joigny* to *Paris*, there are *changes* in the *strata;* those of *chalk*, which are the first that occur in this road, are succeeded by others of *sand-stones* and of *sand*, and lastly by the *lime-stone strata* found in the neighbourhood of *Paris*, very different in their nature from those that I have hitherto described, the stone being softer, and capable of being sawn.

146. If together with the above descriptions, are now considered those which are contained in the Travels of M. de Saussure, it will be evident how extensive a tract of the bed of the ancient sea was occupied by the class of *calcareous strata* composing the chain of the *Jura*, which extends the whole way

from *Grenoble* to *Basle*, as well as, in an almost parallel direction, from *Mont-Salève* to *Montmeillan* in *Savoy:* for this chain of mountains is often double, and sometimes even triple; and the same strata of *lime-stone* which compose it are covered in some parts by strata of the *sand-stone* that prevails over part of *Savoy*, *Dauphiné*, *Lyonnois*, Bresse, *Burgundy*, and *Franche-Comté*.

147. The countries that I have now described are certainly very remarkable, from the geological monuments, which are here more varied and more numerous than within any tracts of equal extent in other parts of the continent: these countries, therefore, well deserve the attention of persons who wish, in a short time, to obtain a precise knowledge of the facts, which all, who write any *history of the Earth*, ought to take for its foundation. That these facts are general cannot indeed be determined from the observation of a single country; but there are no countries where the greater part of those which I have described may not be observed; and I have extended my travels over a sufficient variety of soils to be very well assured that no facts contrary to the conclusions which I have drawn in the course of this journey can any where be found. However, as I have no right to expect to persuade others from my own conviction, and as this conviction is founded on the observations made in my various travels, the latest of which have recently been published in three volumes, I shall now proceed to give an account of

surface was formed, in some places by the upper section of the *strata* strongly inclining inwards.

June 10*th* to 12*th*. From *Dijon*, the same *lime-stone strata* extend by *Villeneuve* and *Monbar* as far as *Joigny;* they bear throughout the same symptoms of catastrophes, forming *hills* intersected by *vales;* the hills frequently presenting *abrupt sides* towards the parts where the greatest subsidences have taken place. Moreover, the effects of time are everywhere visible in the *slopes* of *rubbish* under the rocks; for some of these slopes are entirely overspread by vegetation, while others are more or less bare, because, as the rocks rise to a greater height above them, they are still occasionally subject to be covered by fresh falls of loose materials. From *Joigny* to *Paris*, there are *changes* in the *strata;* those of *chalk*, which are the first that occur in this road, are succeeded by others of *sand-stones* and of *sand*, and lastly by the *lime-stone strata* found in the neighbourhood of *Paris*, very different in their nature from those that I have hitherto described, the stone being softer, and capable of being sawn.

146. If together with the above descriptions, are now considered those which are contained in the Travels of M. de Saussure, it will be evident how extensive a tract of the bed of the ancient sea was occupied by the class of *calcareous strata* composing the chain of the *Jura*, which extends the whole way

from *Grenoble* to *Basle*, as well as, in an almost parallel direction, from *Mont-Salève* to *Montmeillan* in *Savoy:* for this chain of mountains is often double, and sometimes even triple; and the same strata of *lime-stone* which compose it are covered in some parts by strata of the *sand-stone* that prevails over part of *Savoy*, *Dauphiné*, *Lyonnois*, *Bresse*, *Burgundy*, and *Franche-Comté*.

147. The countries that I have now described are certainly very remarkable, from the geological monuments, which are here more varied and more numerous than within any tracts of equal extent in other parts of the continent: these countries, therefore, well deserve the attention of persons who wish, in a short time, to obtain a precise knowledge of the facts, which all, who write any *history of the Earth*, ought to take for its foundation. That these facts are general cannot indeed be determined from the observation of a single country; but there are no countries where the greater part of those which I have described may not be observed; and I have extended my travels over a sufficient variety of soils to be very well assured that no facts contrary to the conclusions which I have drawn in the course of this journey can any where be found. However, as I have no right to expect to persuade others from my own conviction, and as this conviction is founded on the observations made in my various travels, the latest of which have recently been published in three volumes, I shall now proceed to give an account of

his hypotheses, while at the same time, having observed but little, he has given his *determinations* as the *facts* themselves.

149. The following is the manner in which this author, in his xviiith Note, entitled *Transportation of Stones,* attempts to prove, that the *stones disseminated* on the continents have been detached from *mountains* of their own kind, and carried down by *running waters* to the spots where they are at present found. "It is a fact very *generally observed,* " that where the *valleys* among *primitive mountains* " open into *large plains,* the *gravel* of those *plains* " consists of stones, evidently derived from the " *mountains.* The nearer that any spot is to the " mountains, the *larger* are the gravel stones, and " the less *rounded* is their figure; and as the *dis-* " *tance* increases, this *gravel,* which often forms a " stratum nearly level, is covered with a thicker " bed of earth or vegetable soil." Undoubtedly this is what ought to be *generally observed,* if these *blocks,* with the smaller masses, had really been brought down from mountains, and disseminated over lower grounds, by *running waters;* and Mr. Playfair, drawing this inference from his own hypothesis, has accordingly asserted it as a *fact.* But if nothing like this is observed; if *blocks* and other stones are often accumulated in larger quantities at very great distances from mountains of their own kind, than in the immediate vicinity of such mountains; if, between spots where they are scattered in

vast abundance, there are wide intervals in which none are found; if these *blocks* are of genera and species of stones of which none of the *mountains*, within a wide extent of country, are known to be composed; the hypothesis, on the contrary, must necessarily fall to the ground, and there cannot remain for these masses any other source, than that so clearly indicated by the disorder of the *strata* in the mountains, the hills, and the plains; namely, that, in the *catastrophes* of those strata, by which, and not by the action of *running waters*, the *vallies* were produced, the above fragments were thrown out on the surface, by the explosions of the *fluids* compressed in the caverns in which the subsidences took place. Here then the question is clearly brought to an issue; and its importance in the *History of the Earth* cannot but be felt. Of the *facts* which will be described in the following travels, the application to this question will easily be made.

150. I began the journey, of which I am now going to give an account, with a lady who was going to her relations at *Hittefeldt*, in the country of *Hanover*. We quitted *England* in the month of July, 1786, and having landed at *Calais*, we proceeded from that town to *Dusseldorf*, where we passed the *Rhine*; and it is only from the latter place that I shall begin to relate my observations.

July 29th, 1786. We set out from *Dusseldorf* for *Osnaburg*; but before I enter into the detail of my observations on the road, I ought to remark that the *Hartz* mountains, though nearer to this part of the country than any others composed of *primordial strata*, are not only at a great distance from it, but are separated from it by many chains of *hills*, some of which are very lofty, and consist of *strata* of *lime-stone*, *sand-stone*, or pure *sand*; and that the *vallies* or *plains* in the intervals of these are evidently the effects of catastrophes of the *strata*, as will be seen in the course of my descriptions; whence it is absolutely impossible to suppose, that the *blocks* and other masses of *primordial stones*, which I shall shew to abound so greatly in certain spots, while there are none in the intermediate parts, can in any manner, or at any time, have *migrated* on the *continent* since it has become dry land.

151. From *Dusseldorf*, our first stage was to *Dulmen*; and in both these towns, as well as in all the villages between them, the pavements, the foundations of the wooden houses, and the stone posts placed to keep off carriages, consisted of *primordial stones*, either entire or in fragments, the latter being pieces of large masses which had been split with gunpowder, because their size had rendered it impracticable to remove them out of the fields, at the time when the land was first brought into tillage: I saw likewise many scattered *blocks* on the heaths, partly buried in the earth; and in some places, where, in order to soften the declivities, the road had been cut to a considerable depth in the higher

grounds,

grounds, I saw on its sides very large *blocks* lying eight or ten feet below the surface. However, soon after we had passed *Dulmen*, I observed a great diminution in the quantity, first of the *blocks*, and afterwards of the smaller masses, till at last we came to an extensive space, where I did not see even the minute gravel of *white quartz* so generally spread over the surface of these countries; there was here nothing but pure *sand*, which, in places where the soil was cut through to a great depth, was seen to lie in regular *strata*.

152. Between *Lengerick* and *Osnaburg*, we crossed three ridges of hills of considerable height; and as the horses ascended them very slowly, I quitted the carriage and walked. The base of the first of these ridges, which is every where covered with a great thickness of *sand*, consists of *strata* of *lime-stone* containing *marine bodies*, as I saw in several very deep fractures. It cannot therefore be doubted, that these *strata* were produced by the sea. The upper part, as I shall shew to be the case in several hills, is composed of *sand-stones;* but I could not distinguish its *strata*. This stone is all broken into parallelopipeds; even its smallest fragments bearing that form. On these hills I did not see any *blocks* of *primordial stones;* but I observed a great quantity in the interval between this ridge and the second, where the soil is of sand, intermixed on the surface with abundance of fragments of *lime-stone* and of *sand-stone*. The second ridge, which is also

covered with a great thickness of *sand*, appeared to me, in some parts where it was deeply cut, to have *sand-stone* for its base; in crossing it, I saw but few *primordial stones.* In the third ridge, behind which *Osnaburg* lies, I could perceive nothing, in the deepest cuts, but *strata* of *sand;* and these *strata,* as is the case in many hills, have undergone an *angular movement*, together with the *stony strata* beneath them; for their *inclination* follows that of the rapid slope. In a large excavation out of which this sand had been taken, I saw a *block* of *granite* four or five feet in diameter.

July 30*th.* In *Osnaburg* are to be seen as many *primordial stones* as in any town in the centre of the *Alps;* the whole city is paved with them; *blocks* of this kind form the foundations of all the wooden houses, and the stone posts along the pavements are fragments of large *blocks.*

153. I was surprized at the great abundance o these stones, not having seen many of them on th last of the ridges over which we had passed; bu we soon, to our own cost, discovered their source for when, proceeding towards *Böhmte*, on the roa to *Hanover*, we ascended the hills beyond *Osnaburg* I not only saw quantities of *blocks* scattered on th heath, but the road itself was more dangerous fo carriages than any over which I remembered eve to have passed; it consisted of loose sand, covering a quantity of *blocks* and smaller stones. No advan-

tage was to be gained by going on the heath, for the stones were there equally abundant; our postilion therefore proceeded along the road, but very slowly, and we were jolted at every step; at last, one of the fore-wheels being stopped by a block, he lashed his horses, hoping either to force the obstacle out of its place, or to make the wheel pass over it; but he succeeded in neither of these views; for the axle-tree broke. We had already left *Osnaburg* a league behind us; but as it was the nearest place from which we could have any assistance, we had no resource but to procure from that city a set of fore-wheels, to enable our carriage to return thither, and have its axle-tree mended. Being anxious that this should be done as quickly as possible, that the lady with whom I travelled might not be long detained in the middle of the high road, I left with her our servant and the postillion, and rode back myself to *Osnaburg* on the horse of the latter.

154. As the high road formed a wide bend, I quitted it, in order to take a straiter way along the brow of the hill; and here I saw below me one of the phenomena which had suggested to M. SILBERSCHLAG of *Berlin* his system of the *rupture* of the *strata* by *volcanic explosions*. I shall not enter into details respecting his system, it having been formed at a time when geological monuments had been very little studied: but even then he was sensible that the masses of *granite* and other stones of the same class, of which such immense quantities

are found in certain spots, could not have proceeded but from within, whence by an *explosion* of some kind or other, they had been ejected on the surface; and he had been led to this idea by observing some vast funnel-shaped cavities, resembling the *craters* of volcanoes, of which all the interior circumference was covered with these *blocks*.

155. It was on a cavity of this kind that I now looked down; and I shall have occasion, in the sequel, to mention several others. Its circumference above, whereof the hill over which I was now passing formed a part, appeared to be about a league in diameter; the space below, whence the waters found no discharge but on one side, was a peat moss covered like all the slopes of the surrounding hills, with heath. This cavity must have existed at the origin of the continent; for it cannot have been formed by any cause in action since that period. No doubt, therefore, can be entertained that it was the focus of *explosion* of the fluids which were compressed within, by the *subsidence* of all the *strata*, including the *primordial*, and that from this point were thrown out the masses scattered on the hill; for all the slopes around this apparent *crater* are strewn with *blocks*, which, from a distance, look like flocks of sheep grazing on the heath. On my arrival at *Osnaburg*, I immediately obtained a set of fore-wheels, by means of which our carriage was taken back to that city, where the rest of the day was spent in repairing it.

July 31*st*. As we wished this day to reach *Hittefeldt*, and were aware of all the dangers of our road as far as *Bohmte*, we set out from *Osnaburg* very early. Having had the good fortune to arrive safely at *Bohmte*, we proceeded on the *Hanover* road as far as *Leese*, whence we turned to the north towards *Harborg*, a port in the gulph of the *Elbe* which is opposite to *Hamburg*, and up to which the tides ascend. In our way by *Nienburg* to *Wisselhöfe*, we passed over great inflexions of the ground; and the heath still appeared to be covered with flocks of sheep, so near did the *blocks* here lie to each other. Between the two latter towns, we were again violently jolted by the quantity of large stones in the sand. Were a torrent, therefore, to pass over these hills, and to wash away the sand in its course, its bed would appear exactly similar to that of the streams which flow here in the vallies, where their only operation has been to carry down the loose soil; for the stones in the *vallies*, as well as those on the *hills*, lay in their present situations before the action of the running waters had commenced.

August 1*st*, 2*d*, *and* 3*d*. I spent these days at *Hittefeldt* with my fellow-traveller and her relations. This village is situated at the bottom of a vale; and I made several excursions over the surrounding hills. Here, as is the case around many other villages in these countries, the *blocks*, together with the smaller masses of stone, have been removed, for the double purpose of building the houses, and of clearing

ing the lands for cultivation; thus I saw but few or the surface; but in one place, where a road ha been cut to a considerable depth, I perceived on its sides some very large *blocks* of *granite*. Here I had time to pay more attention to the *flints*, of which, as I have mentioned in my other travels, great quantities are scattered over the surface of these countries; on some of them I saw impressions of the spines of *echinites*; others contained *entrochi*; and having broken one of the largest, I found in it a cavity filled with *chalk*, very white and soft to the touch: in short, these *flints* have all the characters of those which are found in existing *strata* of *chalk*; yet no such *strata* appear either in this country, or within a great distance around it. This is a confirmation of what I have said elsewhere respecting the *flints* scattered over so many parts of the continents; namely, that they were formed in *strata* o *chalk*, which had themselves been *precipitated* at a anterior epoch, and which the sea, at a certain period, and on some particular parts of its bed, became capable of *dissolving*, leaving entire only th small masses thus converted into *flints*.

August 4th. I set out from *Hittefeldt* for *Hanover*, passing through *Zarrendorff*, *Witzendorff*, *Zel* and *Engensen*.

156. The whole way from *Hittefeldt* to *Zarrendorff*, I continued to see *blocks* and *smaller masses* o *granite* and other *primordial stones*, and the sand o

th

the road every where contained *gravel* of those *stones* intermixed with *flints.* The *blocks* lay in the greatest abundance in large concavities of the same form as that described above near *Osnaburg;* in particular, I saw one near *Zarrendorff*, about a quarter of a league in diameter, of which likewise the bottom was occupied by *peat*, and the interior slopes were covered with *blocks.* I remarked also in several places, where the road had been cut to some depth in eminences in order to lessen their declivity, that the superficial soil consisted chiefly of *blocks* and other rounded masses of all sizes.

157. In the road from *Zarrendorff* to *Witzendorff*, I passed over a large space, entirely destitute of vegetation; for the *sand* was there so loose, that it was continually driven about by the winds, which presently destroyed the *dunes* that they had raised in one spot, in order to form them afresh in another; not even allowing time for the *carex arenaria* to spring up on them. In this space, the *currents of air* afforded an example of the effect which I have already said would be produced on these hills by *currents of water.* The sinuosities of the surface, increased by the *dunes*, had given particular directions to the *currents of* air, which having, like *rivers* in vallies, or *torrents* on slopes, carried away all the *sand* in their course, the furrows thus produced had their bottom covered with *blocks*, all *rounded*, as well as the smaller masses, and even the *gravel*, in the same manner as is seen on the beds of torrents;

rents; such having previously been the state of these stones within the superficial soil, even on the summit of the hills.

158. Between *Witzendorff* and *Zell* (or *Celle*) occurs one of those spaces in which the *blocks*, and even the smaller stones, are almost entirely discontinued; so that, for a long time, I saw nothing but a minute gravel, chiefly composed of *flints*. My old friend Professor DE ROQUES, who had settled at *Zell*, was at this time still alive: having been long an inhabitant of the country, this able naturalist had made a most interesting collection of the *marine bodies* contained in the *flints* here scattered over the sands; and he had lately added to it one of a kind which I had not myself happened to find, namely, the *palate* of a *fish*. There are many *blocks* of *granite* in the town, and in its pavement I observed likewise a great variety of other *primordial stones*. I had formerly made a longer abode at *Zell*; and in the course of my walks in its neighbourhood, I had then seen a hill from which these masses were brought.

159. At some distance from *Zell*, the *blocks* first, and then the smaller masses, again disappeared; after which, the whole way to *Engensen*, I saw no stones except the small gravel of *white quartz* and of *flint*. The *sand* here covers the ruins of *strata* of a very fine *sand-stone*, used for the purpose of facing the houses. I call these the *ruins* of *strata*;

for in many places it is their upper section which presents itself immediately under the *sand;* and when they are followed in the quarries, they are found to be strongly inclined inwards. Here I had an opportunity of seeing the proof which I have met with equally wherever I have been, that the sand now covering the *strata* of *sand-stone* must have been spread over the surface at a period posterior to the formation of these *strata*, as well as those of any other *solid* kind; namely, that, wherever the *strata* of this superficial *sand* are not of very great thickness, they contain throughout the whole of their mass, small gravel of *white quartz*, and sometimes of *flint;* while the *sand*, consolidated in those of the *sand-stone* beneath them is perfectly pure. In the sequel will appear a proof of a different kind.

160. Between *Engensen* and *Hanover*, I came to another space much covered with *blocks*, of which I saw great numbers collected together in a village; afterwards they again disappeared; and for a long way before I reached *Hanover*, I saw in the sand the small gravel of *white quartz* only, with some fragments of *flint*.

August 5th—13th. At *Hanover* I was so fortunate as to meet with some persons whom I much loved and esteemed. Here also I again saw the interesting collection of minerals and organic fossils belonging to M. ANDRE, who shewed me, in particular, some fragments of very large *cornua Ammonis* covered with pyrites, and a number of the same shells of a smaller size, which had been found in *argillaceous strata*, at a league's distance from the town, by a peasant who had undertaken to dig a well near his own house. He had met with these *strata*, at a certain depth, beneath the sand; but after having gone down in them a considerable way, he had despaired of being able to penetrate through them, and had therefore abandoned the enterprize. This is one of the proofs, which I have likewise seen in many other places, of the mistake of those who have supposed the *sand*, scattered over so great a variety of countries, to proceed from the *detritus* of *granite;* for these *argillaceous strata*, which contain *marine bodies*, must evidently have been formed in the sea; and here, as is elsewhere likewise so frequently the case, they are immediately covered by the *sandy strata*.

161. As soon as I arrived at *Hanover*, I wrote to my worthy friend the late Baron Von Reden, who was then at *Clausthal*, the chief town of the *Hartz*, where he was Director of the Mines, expressing my wish once more to visit those mountains, and at the same time inviting him to accompany me in another very interesting excursion. M. De la Trobe, for whom I have much esteem, and who is minister of the *Moravian* congregation in *London* had communicated to me letters which he had re ceived from Dr. B. C. Taust, and M. J. H. An dresen, two of his friends in *Germany*, who, hav ing read my *Lettres sur l'Histoire de la Terre et d*

l'Homme, and learnt that I had observed several of the mountains of *Hesse*, which was their native country, had both expressed much regret that I had not visited the *Meisner*, a mountain containing a very thick bed of *fossile vegetables* under *strata* of *basalt*, and another eminence near *Münden*, which likewise contains these *vegetables*. These, therefore, were the spots that I wished to observe with the Baron; who, agreeing to the plan with much pleasure, was so kind as to come to *Hanover* to meet me, that I might first go back with him to the *Hartz*, and that we might then proceed together to *Münden* and to the *Meisner*, whence I had informed him that I intended to return through *Hesse* to *England*.

August 14*th*. I set out from *Hanover* with Baron Von Reden at a very early hour, because we were to go first to his seat at *Hastenbeck*, and he was desirous that we should have leisure to make observations on the road; for, from the time of our first excursions together, he had been struck, like myself, by the changes in the *strata* from place to place, and by the masses of stone, which, though scattered over them, were yet of natures foreign to their own.

162. After we had crossed the small river *Leine*, which passes through *Hanover*, I remarked that, in all the villages, the houses were built of fragments of *lime-stone;* and on inquiring whence it came, we learnt that, throughout an extensive tract of

country on this left side of the river, *lime-stone* is found at various depths beneath the *sand*, not however in continuous strata, but always in fragments; on which account it is only proper for building rough walls, for making lime, and for gravelling the road. We then advanced towards a ridge of hills called the *Deister*, rising considerably on the right of our road, which however passed over its lowest part. Here the *stony strata* suddenly change; for we saw large quarries of a beautiful grey *sand-stone* with a fine grain, easily cut, and employed in facing houses. The *strata* of this stone are very thick, and incline the same way with the rapid slope by which we ascended, being covered at the foot of the latter by the loose soil. After we had crossed this low part of the *Deister*, we found beyond it several longitudinal vallies, formed by interrupted ridges of hills, which, on the side nearest to the *Deister*, present *sections* of the same *strata* inclined towards the opposite side, where their greatest *subsidence*, attended with the *angular motion* of their masses divided by fractures, must consequently have taken place.

163. Of this catastrophe we afterwards observed another monument in the *blocks* ejected from within. We saw the slope by which we had descended the *Deister* strewed with *blocks* of a hard yellowish *sand-stone*, quite different from that of the exterior *strata*; we found the same *blocks* scattered also in the vallies; and as we turned round the extremity

of a hill above *Hastenbeck*, we saw in some places, where hillocks had been cut through to make the road, that, among stones of the above kind, many large *blocks* of *granite* were buried in the loose soil. The Baron was well acquainted with this hill, for it formed a part of his own estate; it was covered with a wood, in which some quarries had been opened; and he assured me that the *blocks* of yellowish *sand-stone* scattered over the surface were no less extraneous than those of *granite* to all the strata which had been discovered in it. We arrived in the evening at *Hostenbeck*.

August 15*th*. We went this day to *Pyrmont*, for the purpose of observing a greater extent of this country, where most of the *blocks* are quite different in their nature from those on the other side of the *Deister*. On setting out from *Hastenbeck*, we went down into a very large low space, inundated every winter by the waters descending from the hills, and by the *Weser*, which in this part is not confined by its right bank. The whole of the low soil has been levelled by these waters; and we saw no *blocks* here, probably because they were buried under the small gravel; but we met with them again at *Hohlen*, where we crossed the *Weser*. In this village there were *blocks*, both of *granite*, and of the *hard sand-stone*, which had been taken out of the fields. Above this place, the hills on the left bank present abrupt sides to the river, and to the plain forming its opposite bank; whence the latter, and the channel of the stream lying below its level, are seen very manifestly to have been produced by *subsidence.*

164. The appearance of the country extending the whole way from hence to *Pyrmont* induced me to proceed on foot to that place, that I might observe every object more particularly. Here appear evident proofs, not only of the catastrophes of the *strata,* but of their subversion, which is clearly shewn by those changes of species at the same level, that had so much struck Baron Von Reden. There is here an assemblage of insulated *hills,* dispersed without any order, and bearing no resemblance to each other in their form: many of them present *abrupt sides,* in which the *strata* are seen to incline towards different points; but the most remarkable circumstance is that some of these hills consist of *lime-stone,* and others of *sand-stone;* though what I have already shewn in the space between the *Jura* and the *Alps* is here known to be the case throughout the whole country; viz. that the former *strata* were originally covered by the latter. In the sand of the road, I saw some small masses of *granite,* but a greater number of the *hard sand-stone,* the scattered *blocks* of which might, from a distance, have been taken for *granite,* the parts rising above the grass being, in a similar manner, overspread with lichens. I passed by one spot, where the loose sand was full of these *blocks;* whence I perceived a mistake into which I had fallen in my first travels

through this country, and on the mountains of *Hesse.* In my account of those travels, I gave to these masses the name of *grès;* meaning, by that word, to signify partial *concretions* formed in *sand;* because in other countries, especially in *Piedmont,* I had observed *concretions* which had certainly been formed in *sand,* as others are often found to have been in *clay.* But here I first perceived my error, of which I became afterwards fully convinced; for it will be seen in the course of this journey, that these masses of *sand-stone,* possessing all the hardness and brilliancy of *granulated quartz,* are scattered over *strata* of every class throughout a very wide extent of country, where they are more or less intermixed with masses of the inferior *strata,* viz. *granite,* and the other *primordial* kinds: and it will soon appear that this phenomenon of scattered masses, analogous to known *strata,* and yet not proceeding from any which are visible in the country, is not confined to *sand-stone* and *granulated quartz.* As I had before visited the neighbourhood of *Pyrmont,* and had described it in my first travels, we did not now make any stay at that place, but returned to *Hastenbeck.*

Aug. 16*th.* We set out for *Esbek,* another seat belonging to the Baron, who proposed that we should spend the day there; this place lay on a road leading to the *Hartz;* but his principal motive for taking me thither was to shew me a very extraordinary instance of *masses of stone* extraneo to the *strata* on which they lie.

165. Till we approached *Eime* in the bailiwi of *Lauenstein*, we continued to find scattered *bloc* of *granite*, but many more of the *hard sand-sto* We then entered the high road from *Hanover* *Gottingen*, in which we proceeded for some way the valley of the *Leine*. This road was gravelled fragments of *lime-stone* taken up from beneath superficial soil, where its *strata* are in the shatt state already described; this stone is full of *ma* *bodies*, and chiefly of *entrochi*. The *valley* is on sides bordered by chains of eminences composed of same *strata*, which present towards it *abrupt f* and descend on their opposite sides with a ge declivity. These chains are not continuous, but so deeply intersected as to form separate h which rise in sharp ridges, sloping downwards hind; and from their intervals issue only some ri lets formed by springs. It is impossible not perceive, that the *strata* must have been reduce this state by catastrophes, during which the subside of a large mass between two irregular fractures, duced the *valley* itself, in some places widening small *plains*; and that the *caverns*, whereby *subsidence* was occasioned, being of different de and unequally distributed, other fragments of strata subsided betwixt those masses which remai at a higher level, and which themselves under

ang

angular movements, in consequence of the inequalities of the bottom. Some strange effects of these catastrophes will soon appear.

166. We entered an interval of these hills, forming the first of a succession of vallies which extend from hence towards *Clausthal*, and in one of which *Esbeck* is situated. After we had crossed the first ridge of hills, we saw large *blocks* at the sides of the fields, and also in the loose soil wherever it was deeply cut to make the road. In form and situation, these *blocks* had all the appearance of those of *anite* and *hard sand-stone* which we had before bserved; and such parts of them as rose here and ere above the grass were also covered with *lichens;* ut they were no longer of the same nature, for ey consisted of a very hard *lime-stone*, differing eatly from that which appears externally, and not ntaining the same *marine bodies*.

167. When we had reached the hills which border e valley of *Esbeck*, and were passing over the foot those on our right, we saw the surface covered ith gravel mixed with large masses of *granite* and *ranulated quartz*. We had ascended above the able grounds to a tract between them and the oods, which serves only for pasture, being left to ts own spontaneous product, on account of the reat irregularity of its surface, and the abundance the large *blocks* of *hard lime-stone*. On ariving pposite to *Esbeck*, the Baron pointed out the phe-

nomenon which he had previously mentioned t
consisting of masses of the *hard lime stone*
large a size that they were worked as qua
This stone is so compact, and of so fine a grain,
it may be cut in every direction, according on
the form and situation of the masses; it is use
facing houses, and large pillars for court-gate
made of it; I examined the surfaces which
been long exposed to the air, and could not per
on them any *marine bodies*, except some
fungites. The Baron afterwards led me to
places where masses of this kind had been ent
cleared away; and there I saw that, as he
told me, they had lain on rubbish of the ston
the hill, which is very different from that of
blocks.

168. We then ascended through the wood
the higher part of the ridge, on the brow of w
we found several sections of the *strata* ope
view above the slopes composed of their own
bish; these *strata* also are *calcareous*, but they
foliated, and contain several kinds of marine bo
as is the case with all the others which are visi
they incline towards the interior part of the mo
tain, and rising towards the *valley* of *Esbeck*,
sent on that side their section. The Baron poi
out to me several rocks appearing in a line with
other among the trees, which he told me were
the same hard *lime-stone* as the first that we
seen, and were also without adherence to the m

with wood, and descend from a distance down to the shores of the river, to consist of an *argillaceous* soil, mingled with rounded stones of various kinds, among which there were some of *granite* and of *white quartz*.

170. Having crossed the ridge of hills on the right bank, we arrived at *Gandersheim*, a small town situated in a higher valley, along which we proceeded by *Mönchhof* and *Kirchberg*, between mountains composed of *strata* of *lime-stone*. As we advanced, we came within view of the *granitic* chain of the *Hartz*, which presented itself before us in an oblique direction. Though we were now so near this chain, we saw no *blocks* of *granite*, but many of the *hard lime-stone*, though still absolutely extraneous to the *strata* of the mountains which border this valley. Thus the *granitic blocks* scattered over the country behind us could not have been transported hither from the *Hartz*, because in that case, as this is the only road they could have taken, they would certainly be found in greater abundance here than in other places, as being nearer to their source; according to Mr. Playfair's conclusion, (§ 149;) but it will be seen, as we go farther, what obstacles they would have encountered by the way.

171. The first chain of mountains that we crossed in proceeding towards *Clausthal* is very remarkable, as shewing *vallies* to have been certainly produced

by the *catastrophes* of the *strata.* The side on which we ascended it, by a steep road, we found to be still composed of *lime-stone strata;* while the more rapid side on which we descended into a much lower valley, wherein stands *Grund,* (the first town belonging to the mines,) consists of *strata* of *schistus,* strongly inclined, and in some places nearly vertical. In the ivth. Vol. of my *Lettres sur l'Histoire de la Terre et de l'Homme,* I have described the *Ostkamp,* which is a *calcareous* eminence belonging to this chain, and rising on the *schisti.*

172. From this deep valley, we crossed another ridge of mountains, to which we had a long ascent on a slope composed entirely of rubbish. At the top of this slope, we found the *schistose strata* very much inclined, their direction being the same as in the chain to which the *Ostkamp* belongs; but at some distance from the point where we crossed this new chain, rises the *Winterberg,* another eminence composed of *strata* of *lime-stone* on *schistus.*

173. Before we arrived at *Clausthal,* we crossed several other ridges of *mountains,* and consequently several *vallies:* all the *strata* are here broken and overturned; and they have changed their situation in so many different ways, that to describe them would be difficult as well as tedious. Some years before, Baron Von Reden having been in *England,* I had had the pleasure of accompanying him into *Shropshire,* whence he had proceeded to *Anglesea,* in

order to observe the *veins of copper* in that island, very similar to those of *Ramelsberg* belonging to the *Hartz*, as described in my first travels: now as we were considering the chains of mountains which we were at present crossing, where, in spots very near each other the *strata* of *lime-stone* are found at the same level as those of *schistus*, the Baron told me that he had observed the same circumstance in passing over from *Wales* to the *Isle of Anglesea*, which is divided from the land by the strait of *Menai*, a narrow channel that may be considered as nothing more than a *valley*. The Welch coast, in this part, consists of *lime-stone strata*, and their planes, rising towards the *strait*, are there cut off abruptly while the *island* is composed of *strata* of *schistus* which, inclining towards the strait, apparently cross it, and descend beneath those of *lime-stone*: but on the side of the island next the open sea, the *schistos* *strata* assume an opposite inclination. The larg *veins* of *copper* incline inwards, and their section has been found at the surface. Thus (as I have shewn in my travels to be likewise the case on other coasts of *Great Britain*) the catastrophes of the *strata*, of which so many effects appear in the inland parts of the *continents*, have been also extended to their confines towards the sea, where they have produced *islands* separated from the *coast* by *straits*, in the same manner as, on the *continents* themselves, ridges of *eminences* are separated by *vallies*; and the sides of these *straits* are often as different from each other as those of some *vallies*.

Aug. 18*th, and* 19*th.* I spent these two days at *Clausthal;* and in our walks, Baron Von Reden led me to spots where the *false veins,* or *cross courses* as they are called in *Cornwall,* appear externally in the abrupt sides of the hills. These are very important *monuments* in the history of our continents, because they indicate very distinct *epochs* in the *catastrophes* of the *strata.* It is evident that the *catastrophes* which occasioned the formation of these *false veins,* containing in their *gangue* scarcely any metallic particles, must have been very much posterior to those that produced the *fissures* wherein are the *true* or *metalliferous veins;* since the latter, at the time when they were intersected by the former, were already filled with their *gangue,* which, as I shall have occasion to shew, was formed but slowly. These last *catastrophes* must have been the most considerable; for in them the *true veins* were broken, and subjected to the great *angular movements,* in consequence of which they now present their sections on the sides of the *vallies,* produced at the same period by the *subsidence* of masses containing parts of these *veins;* a circumstance whereof I have given examples in *England,* as I shall presently do in the *Hartz.* In the section of a *false vein* shewn me by the Baron, I saw another instance of the great dislocations which then took place; the abrupt side wherein this section appears, must have been the result of a still later catastrophe; the false vein, when thus cut off, having been also filled with its *gangue.* Though this *false vein* is only about half a foot in breadth, its sides are entirely different from each other, one of them consisting of *schistus* much foliated, and the other of *grey wacke;* hence it is evident that, when this *fracture* was made, the mass on one side sunk much lower than that on the other. The course of all the *false veins* is known in the *Hartz*, as that of the *cross courses* is in *Cornwall;* but the phenomena differ in the different countries of mines. Most of the *cross courses* in *Cornwall* are much wider than the *false veins* in the *Hartz:* there is however this analogy between them; that, in both countries, there is sometimes a difference in the abundance or the nature of the metalliferous parts in the *true veins,* on the opposite sides of the *false* ones which intersect them.

Aug. 20th. There is, in the *Hartz*, a district of mines called *St. Andreasberg*, where, in my former travels, I had seen only *veins* of *hæmatites iron;* but in the same district there are also some *veins* of *lead*, which are very rich in *silver;* and on my expressing to Baron Von Reden a wish to observe them, he told me that we might take these mines in our road towards the mountains of *Hesse*.

174. We set out in the morning from *Clausthal* on horseback, and went first towards *Oder Teich*, in the way to the *Blocksberg*, or *Great Brocken*, which is the highest summit of the *Hartz*, and

consists of *granite.* We passed through a great forest of firs on the continuation of the mountain of *Clausthal,* where the whole superficial soil is entirely extraneous to the *strata* of the mountain, which, from the mines within, are known to consist of *schistus* and *grey wacke,* and to be strongly inclined; but the superficial soil is of *loam,* (called *lime* in this part of the country,) that is to say, clay mixed with sand, commonly of a yellowish colour. On this road we found some *blocks* of *granite;* but when, after having crossed the first valley of any considerable breadth, we ascended the *Bruchberg,* we found on a soil of *white sand,* some of those *blocks* of a very different kind, which, in my first journey hither in 1778, I had called *grès,* mistaking them for concretions formed in this *sand.* It was of this error that, as I said § 164, I had now become sensible, perceiving these *blocks* to consist really of *granulated quartz:* as we ascended the mountain, we found their quantity increase, insomuch that, on the summit, they were actually heaped one on another; yet the mountain itself is composed, like the former, of *schistus* and *grey wacke,* and the neighbouring eminences are of *granite.* How striking a symptom of a catastrophe which must have affected all the inferior *strata!* The summit of the *Bruchberg* is covered with *peat,* as are also the two *Brockens,* and their intervals.

175. As we descended the *Bruchberg,* we observed a diminution in the quantity of the *blocks*

of *granulated quartz:* here and there we saw sections of a *schistus* harder than that in the neighbourhood of *Clausthal;* and when we came to the bed of a brook which flows between this ridge of eminences and the next, the *blocks* almost entirely disappeared: but when we had proceeded a little way up the latter ridge, we again met with the same *blocks.* Having crossed these eminences, and passed over another brook, we ascended a higher ridge, where the *strata,* still of the same *hard schistus,* are nearly verticle. We now found a great change in the *blocks,* which here were of *granite,* and which lay on the summit in such abundance as to form a kind of pavement. This summit is of great extent, and is likewise covered with *peat.*

176. We were now approaching the *granitic* mountains, the highest of which is the *Blocksberg;* and hence therefore the geologists, who suppose that *blocks* of *granite* have migrated on the surface, might imagine those just mentioned to have proceeded. I will not oppose to this idea that between the *Blocksberg* and the *Bruchberg* there is a *valley,* because, in the Huttonian theory, *vallies* are supposed to have been excavated subsequently to the migration of the *blocks.* But the latter mountain, which is itself very high, is at such a distance from the former, that a continuous surface could not here have had sufficient declivity to enable the strongest *current* to carry such masses along with it; and how could any stream have flowed from the top

of the *Blocksberg*, a *pyramidal* mountain, and the highest in all the country lying on this side of the *Giants mountains* in *Silesia?* Besides, whence could have proceeded so great a quantity of blocks of *granulated quartz*, of which there are no exterior *strata?*

177. *Oder-Teich*, the place whither we now proceeded, takes its name from a large *dike* (*teich* in German) constructed across the upper part of a valley, for the purpose of making a reservoir for the water of a small stream called the *Oder*, which is thence led by a canal along the foot of the mountains to *St. Andreasberg*, where it sets in motion the pumps and other machinery of the mines. The *schisti* probably do not extend to *Oder-Teich*, or at least they terminate not far beyond it, as it lies in a direction towards the two *Brockens*, and the other *granitic* eminences. In our way to *Oder-Teich*, we found the ground all covered with a sand consisting of decomposed *granite;* a higher eminence, which we passed beyond that place, is of *granite*, and on its summit is a lofty cone entirely formed of *granitic blocks*. The whole space between this eminence and the *Blocksberg* is likewise occupied by accumulations of these *blocks*.

178. Two ridges of mountains, which are separated by the valley on one side of *Oder-Teich*, and both present towards it abrupt sides, approach so near to each other at their foot, that they leave only

space for the shelving bed of the little stream, which falls in repeated cascades among *blocks* of *granite*. It is on the slope of the mountain on the right, called the *Rehberg*, that a road has been made, in a southerly direction, to *St. Andreasberg*. This road is singularly smooth, being composed of granitic sand, which binds and hardens so well, that the rains cannot produce any furrows in it; and it is cut through a fir-wood on so rapid a slope, that it is not easy to imagine how the wood-cutters are able to fell and remove the trees. The water, which is led from *Oder-Teich* to *St. Andreasberg* with a very regular slope, is carried along the side of this road next to the mountain. Within a certain space, the *decomposition* of the *granite* may be here very plainly observed; for some way, among the heaps of *blocks*, and afterwards in the mass of the mountain itself; but the *granite* through which the road has been cut lower down suffers no *decomposition*, and some very remarkable changes appear in it in this respect; that I may not however enlarge too much on the subject, I shall at first speak only of the *granitic sand*, certainly the product of decomposition, which I have found in great abundance on some parts of all the *granitic* mountains that I have visited, as well the *Alps*, as some other mountains in *Germany*, which I shall describe hereafter.

179. In my travels in *Cornwall*, I have said a great deal respecting a *coarse sand* which is called

growan in that county, and is in appearance similar to this; but there are between the two the following very characteristic differences. In the mountains whereof I am now speaking, the *decomposition* of the *granite* which produces this *sand* is seen still to continue; and Baron Von Reden considered it as the cause of the rounding of the blocks, because angles are more exposed than plane surfaces to the actions of the air: in the sequel of these travels will be found some direct proofs of this operation. *Metalliferous particles* are not contained in any perceptible quantity, either in the *granite* of these mountains, or in the *coarse sand* which proceeds from it; for it is evident that, in this respect, there can be no difference between the *granite* itself, and the *sand* seen to be immediately formed from it. The case is very different in *Cornwall* with regard to the *growan*, though, from its appearance, that substance has been likewise taken for a product of *decomposition.* But, in the first place, the *growan*, in many parts of the country, contains *grains* of a very rich *tin ore*, in sufficient abundance to render it worth while to separate them by washing: now none of these *grains* are found in the existing *granite*; neither do they proceed from *veins;* for the *gangue* of the *veins* of *tin* in *Cornwall* is very different from the *growan*, as its *ore* is also from the *tin grains* contained in that substance; it is even very easy to distinguish them from each other, when they have been thrown together by some catastrophe of the *strata*; as in one particular spot I have

shewn

shewn to be the case. I have also described a hill, whereof the mass consists of *growan* laid in indurated *strata*, which have undergone the same *fractures* and *angular movements* as the other *strata:* in this hill, all the *strata* of *growan* are full of *grains* of *tin ore*, and they are worked as quarries; the broken masses being stamped and washed for the purpose of extracting these grains. *Growan*, therefore, is, not *decomposed granite;* it is a *precipitation*, *sui generis*, which took place in the ancient sea; and of this a direct proof is met with in following the *veins* or *loads;* for the *strata* of *growan* are found to alternate with those of *schistus* or *grey wacke*, which are both, in *Cornwall*, known by the name of *kellas*. Such are the striking differences between the Cornish *growan*, and the *granitic sand* produced by *decomposition* in the mountains of which I am now speaking. I return to the description of what we observed along the road cut on the slope of the *Rehberg*.

180. I have mentioned that we came to one part of this road where the *granite*, in which it was cut, suffered no decomposition; but this granite was so much fractured, that it was impossible, as we passed along, to distinguish the *fissures* from the *lines* of separation of the *strata*. About half a league farther on, as we constantly observed the side cut down to make the road, we perceived a *quartzeous stone*, the *strata* of which were very distinct; but we could not see at what point they met those of the

granite,

necessary to perforate a projecting part of t mountain, where, within a space of 80 yards, thing had been found but *blocks* of *granite* bedded in rubbish; beyond which the *schistus* l been reached. At 5 o'clock we arrived at *St. A dreasberg*, and immediately entered the mines; before I proceed to our own observations in th I shall relate what I learnt respecting their hist from Baron Von Reden, and the other officers w accompanied us.

182. A vein rich in *lead* and *silver* has b worked here a very long time, and has been follo to the depth of 1500 feet by means of a drai gallery, or *adit*, called the *Sieber-stoln*, bec it opens into a valley in which flows the small *Sieber*. In ancient times, when the principal v had not been followed so low, and were still productive, no attention was paid to the discove made in opening this *adit*; while, as it was car in a direction across that of the *veins* of t mountain, it intersected many which are mention in ancient registers, as having been worked for so time, and then abandoned, because they afforded profit but little exceeding the expense. But wh a vast increase of expense was incurred by follo ing the principal *veins* to a greater depth, a circu stance common to all the ancient mines, there w two objects to which it became absolutely essent to attend; first, the construction of the machi employed within the mines, together with the labo

and secondly, the extraction of the *ore* from the *gangue* so that as little as possible of it might be lost, together with the subsequent operations of the founderies; and to both these points Baron Von Reden had applied himself with continual care and attention. The working of the *veins* which had been abandoned on the course of the *Sieber-stoln* was then resumed and was found profitable.

188. It was principally on account of one of these veins that the Baron had brought me to *St. Andreasberg*, as he wished to shew me in it a remarkable phenomenon; this vein bears a very singular name, of which the origin is unknown, that of *Die fünf bucher Moses;* (the five books of Moses.) We descended at 5 o'clock, by the shaft of the mine *Felicitas*, down to the *Sieber-stoln*, 450 feet below the entrance, and we continued in the mine till half past 8; however I shall describe in it only the particular phenomenon to which I have just alluded. In following this *vein*, a cavity had been found lined with the most beautiful *crystals of spar;* but unfortunately it had been discovered only by the miners and inferior officers, who seeing that some profit might be made by detaching these druses, and selling them to the curious, they proceeded without either method or precaution, and hus destroyed this little treasure for cabinets. The avity was 2 or 3 feet in breadth, 5 or 6 in height, nd 10 or 12, as at first appeared, in depth; having idened its entrance by means of gunpowder, the

smoke of which spread into the cavity, they then entered with lamps to detach the crystals, trampling under foot such as covered the bottom; and before they had collected many of them, the inside of the cavity was become as black as that of a chimney.

184. Baron Von Reden was not informed of this proceeding, until after the mischief had been done, at least with respect to the large cavity, which had first presented itself to view; but, on coming hither himself, he perceived a fissure at the bottom; and suspecting that there might be another cavity beyond it, he staid to overlook the workmen while they blew up from a distance the sides of the outward cavity; after which he caused them to widen the fissure with pickaxes, hammers, and wedges, and thus was actually opened an entrance into the inner cavity, lined, like the first with crystals of spar: this entrance he ordered to be closed with a door, entrusting the key to one of his officers, who was never to suffer any of the *druses* to be removed but under his own inspection. They were still employed in widening the fissure, at the time when I had arrived at *Clausthal* with the Baron, who had immediately sent orders to hasten the work; so that, on the day of our visit to the mine, we could very well see with a single lamp, the whole interior part of this cavity which had been last discovered.

185. Every thing was prepared when we arrived here, the aperture having been sufficiently widened

for

for the introduction of the upper part of the body, with a lamp in one hand: in this manner we beheld a grotto, several feet in dimension every way, its walls, which were of irregular forms, being entirely covered with crystals of transparent spar, of a beauty not to be fully conceived but at the first moment, because the smoke even of a single lamp at the entrance, being diffused through the whole space by the motion of the air, deprived the crystals of their brilliancy wherever it reached them; nor could all the elegance of these crystals be seen but while they remained in their original situation. They were curiously interwoven with each other, and were of all sizes, from that of the little finger, to that of a needle more minute than is ever used for sewing. The smaller crystals were easily seen to be hexagonal; their sides were perceptibly equal, and they terminated in a plane at right angles with the prism. The larger, while increasing in size, had here and there united together, either in clusters, or across each other; these, at first view, appeared to have only three sides; but, on looking at them more nearly, I saw that their angles were flattened to a plane surface, so that they likewise were hexagons; they terminated in a truncated triangular pyramid. The light of the lamp being reflected by all the facets of which the lustre had not yet been obscured, the brilliancy of the scene was almost dazzling; but it is impossible that the grotto should have long continued in this state. The Baron caused some of the *druses* to be detached with great caution; but as, for this purpose, it was necessary to use the chizel and the hammer, the blows of the latter occasioned the fall of many of the small crystals, before a piece could be separated from the mass: these pieces would however have been most beautiful specimens for a cabinet, could they have been immediately placed there; but I do not believe they could possibly have been carried very far without losing a great deal of their beauty, even though the utmost care were taken to fix them securely on the bottom of a box, where there was nothing to press upon the crystals.

186. Near the bottom of this innermost cavity there were many small apertures, which indicated other cavities behind it: on both sides of the outermost appeared the section of this part of the vein; it was a very thick mass of spar containing some extraneous bodies; and across its thickness there were striæ terminating at the surface in pyramidal crystals, as is seen in the crust of those salts which are formed in vessels by evaporation, when it is broken sideways.

187. From all these characters, it is placed beyond a doubt that the *veins*, formed in the *fissures* of the *strata*, must have received their *gangue* while under the *primordial liquid*, by successive *precipitations*, long continued, against their sides. When the formation of the *metalliferous gangue* was at an end, wherever it had not accumulated sufficie-

ntly on the sides to meet in the middle, the different crystalline particles, *quartz*, and the various species of *spar*, were deposited on both these sides, each forming its own peculiar prisms at the surface; these are what are known by the name of *druses*; and they must have been produced before our continents were abandoned by the sea; for since that epoch, the *veins* have undergone no essential changes: that they had even acquired the whole of their principal *gangue* at a much earlier period, appears by the *fractures* and *angular motions* which they underwent in the catastrophes whence the *false veins* resulted. I shall not at present enlarge farther on this subject, because I shall have occasion to resume it in a journey to the mines of *Freyberg* in *Saxony*, where I had the same advantage as here, of being under the auspices of one of the directors; the celebrated M. Werner having there been my conductor.

Aug. 21*st.* I set out from *St. Andreasberg* for *Göttingen*, and travelled the first part of the road on horseback, with the Baron, as I had done the preceding day. We descended to the lower part of the town, and entered the valley in which the small river *Sieber*, formed by the springs of the surrounding *combes*, begins its course. When we approached the space occupied by this stream during its inundations, we found it covered with *blocks* of *granite*, of the above *quartzeous stone*, and of *granulated quartz*, as well as with other smaller masses; all of which here appear, only becaus the river has washed away the sand wherein the were imbedded; for it has little rapidity, and th same stones are contained in the slopes of th mountains. Having crossed a branch of one o these mountains, we came again beyond it to th little river, which flows round it. Here a carriage was waiting for me; because the Baron was obliged to return for the present to *Clausthal*, whence he was afterwards to meet me at *Göttingen*, that we might set out together on our projected excursion to the mountains of *Hesse*.

188. The *Sieber*, in the part where I had thus returned to it, was flowing in a valley of considerable breadth, along which I proceeded above two hours. The soil of this valley is covered with the same kinds of *stones* as the mountains on its borders; and the grassy slopes of the latter are composed entirely of rubbish. Here and there I saw projecting rocks; some of *wacke*, which were so much fractured that it was impossible to perceive their *strata;* and others of *schistus*, where the *strata*, very distinct, inclined into the interior part of the mountain, their *direction* being oblique, comparatively with that of the *valley;* and evident marks of the catastrophes whence the *valley* resulted by *subsidence* appear in the ridges of hills which border it, and of which the summits are pyramids of the same *strata*.

189. Near *Hertzberg*, the *Sieber* enters an intersection of the eminences on its right bank, opposite to which opens a plain, surrounded with mountains, and as far as I could judge, about 2 leagues in diameter. On the bottom of this plain are scattered the same *stones* as I had seen in the valley above: earth, which is now covered with grass, has been spread over its surface by the rain-waters that fall in it, and by those that descend from the bordering mountains; and these waters, finding issues through many intersections in the mountain near *Hertzberg*, all proceed to discharge themselves into the *Sieber*. My road out of this plain lay across an eminence to *Gieboldehausen*, at which place I staid an hour and a half to rest the horses.

190. I set out again at 2 o'clock; and as all the remainder of my road to *Göttingen* was up and down hill, I went the greater part of the way on foot. The nature of the country had now entirely changed; it was covered with a loamy soil of such thickness, that at first I could only here and there perceive the *stony strata*, which consisted of *sand-stone*, and were very thin at the surface; but coming to a vale, and ascending it some way on the planes of the *strata*, I there saw beneath the former, in an abrupt section, some very regular thick *strata*, which were worked in quarries for building stone. Having crossed this vale, I found on the opposite ridge *strata* of *lime-stone*, rising to the same level as those of the *sand-stone*, from beneath which they issued. I crossed

several successive ridges of eminences composed of these *lime-stone strata*, ascending in every ridge towards the same point, and abruptly cut off on the opposite side; thus manifestly shewing the longitudinal fractures and angular motions of the divided masses, by which the *strata* of *sand-stone*, certainly formed upon those of *lime-stone*, (as is seen to be the case wherever these two classes of *strata* have not been separated during their catastrophes,) have been caused to slide downwards. The uppermost strata of these calcareous hills are as thin as those of the *sand-stone;* they are, however, abundantly scattered with *blocks* of the same *hard lime-stone* of which I had observed such quantities in the valley of *Esbeck.*

191. The last eminence which I ascended, and at the foot of which lies *Göttingen*, is the *Heinberg*, described in the ivth Vol. of my first Travels, p. 645: this eminence likewise consists of *strata* of *lime-stone*, inclined the same way with the preceding; from its summit it is seen to belong to a ridge on the right of the course of the *Leine*, bordering the valley which extends from *Göttingen* to *Hanover*. From my description of the exterior side of the chain on the opposite bank of that river, as I had approached it from *Hastenbeck*, and of the country behind this ridge on the right bank, through which I had now passed in my way from *Hertzberg*, and concerning which I shall add farther particulars in another journey, it may clearly be judged that, throughout a very exten-

sive

Aug. 26th. We set out for *Münden* at 9 in th morning; but it was 4 in the evening before we arrived there, having staid a long time on the hill immediately above *Göttingen*, on account of a remarkable phenomenon, which I had already described i the ivth Vol. of my first travels, but which I wishe at present to observe again more particularly, with reference to the *basalts* on *Mount Meisner.*

192. On the top of this hill is one of the phenomena, of which, in those travels, I gave several examples on a larger scale, calling them *volcanic crowns* they consist of hills forming a kind of scalloped border around a low space resembling a *basin,* greater o less in size. On viewing a spot of this kind, it i impossible to doubt of the formation of the *basin,* b the *sinking* of a *volcanic cone,* attended by the rupture of the lower parts of the great *lavas,* which, having flowed from its summit, had rested on the surrounding *strata,* where they were afterwards covere in part with other *strata;* these broken *lavas* no presenting towards the basin their abrupt sides. I the above work, I illustrated my description of the *volcanic crowns,* by comparing them to the stumps large trees, cut down above the point from whic their main roots branch off, and hollowed out by internal decay: within the hollow are seen sections these *roots;* and the latter, rising in relief above th soil to a certain distance all around, may be trace still farther under the grass with which they are co

vere

193. *a.* In the place already cited in my first Travels, I have described the nature of the *lavas* of the *volcanic crown* of *Dransfeld*, which we now again examined. That these are *lavas* is beyond a doubt; for this *crown*, as well in the form of the interior part of the *basin*, as in that of the branches diverging from it, is similar to those which I visited in *Hesse*, and along the *Rhine*, in the Electorate of *Treves*, and must evidently be ascribed to the same cause; now in the latter crowns are found *porous lavas*, *scoriæ*, *volcanic ashes* mixed with *shorls*, as in existing volcanoes, and *pummice stones*, near *lavas* which are separated into *basaltic* prisms, as well as into *balls*. At *Dransfeld*, the *lavas* are *basaltic*, but of a singular kind; most of the pieces, when separated, are in the form of *polyedrical wedges;* but in the lava itself, these *wedges* are seen to be arranged round a central *spindle-shaped basalt*, which is also *polyedrical.*

194. Our observation was first directed to all the above circumstances at *Dransfeld;* and we afterwards went to the quarries on one side of the *Dransberg*, whence the *basalts* were taken, and where I remarked a singular phenomenon which I had not happened to perceive in my former visit to this spot, probably because the *lava* had not then been opened to so great a depth. It was on the slope, as we were ascending to the quarry, that we first observed certain blackish *balls*, like bullets, some of which were as large as my fist, but others were smaller. Sur-

prized at this appearance, we looked among the heaps of the *basalts* lately detached, and found there more of these *balls*; afterwards, removing the *basalts*, we saw *balls* fall out of several that happened to break; whereupon, taking up some of the *polyedrical wedges*, and striking them with a hammer, we detached the *angles* of those which we succeeded in splitting, and found within a concavity containing a *ball*. The angular parts thus separated were greyish and brittle; but the *balls* were of a darker colour, and very hard.

195. After these observations at *Dransfeld*, we took the road to *Münden*, a town situated near the confluence of the *Fulda* and the *Werra*, which, when united, form the *Weser*. In this road all the *vallies*, becoming gradually lower, appear very evidently to have resulted from *subsidences* more and more considerable proportionally to their vicinity to that which produced the valley wherein the *Weser* flows; those subsidences having been accompanied with *angular motions* of the masses divided by longitudinal *fractures*. Here again the hills composed of *lime-stone* are succeeded by others consisting of *sand-stone*, which are at a lower level, although the *strata* of the latter were certainly deposited on those of the former. Here and there, both these kinds of hills presented abrupt sides, where we saw *sections* of their *strata*; and we every where found *blocks* of *granulated quartz* on the surface. As we approached *Münden*, we saw a small stream, formed on these hills, flow down to the *Weser* through a deep intersection of the rocks

bordering that river, which, from the heights, is seen itself to arrive hither through another intersection, similar to the former, but more considerable.

196. On our arrival at *Münden*, the Grand Bailiff VON HARNSTEIN was so good as to receive us at his house: we had a great deal of conversation with him respecting the objects of our present journey, namely, the *beds of vegetables* in the mountain near *Münden*, and in the *Meisner;* and he told us that in the former, which is called *Cattenbül*, his father had caused to be worked a bed of this nature, consisting of a combustible vegetable substance called *Surturbrandt*, or *brown coal;* with the view of making *alum* on the spot, as is the case on the *Meisner*, from strata of *aluminous earth*, which are also found here. M. Von Harnstein added, that he had himself abandoned this work, because he obtained a greater profit by employing in potteries some *strata* of *white clay*, which are in the same mountain; but that all these various strata might still be easily observed with a guide who had worked on the spot in his father's time, and to whom he would send notice to attend us. It was therefore determined that we should go the next morning to the *Cattenbül*, and proceed in the afternoon to *Gros Almerode*, in the valley commanded by the *Meisner*, which we might then ascend the following day.

Aug. 27*th.* We set out from *Münden* at 8 in the morning; and the Chief Ranger M. GERMANN was so good as to accompany us the first part of the way, in order to recommend us to the man whom M. Von Harnstein had proposed as our guide.

197. At the beginning of the ascent, we saw, on the slope of the mountain on the right, a quarry out of which M. Germann informed us that mill-stones were taken. We went up to this quarry, though not without great difficulty, and we found a projecting rock of a very hard white *sand-stone*, almost a species of *granulated quartz*, with strata descending very rapidly into the interior part of the mountain, which is very high, and is of considerable extent behind, where it is covered with woods and meadows; its foot, on the side next *Münden*, is cultivated in gardens; so that, were it not for the abrupt part in which the quarry has been opened, the interior state of this mountain would be entirely unknown; for, even on the same side, its slope above the quarry is covered by rubbish overspread with vegetation. However, from the open *section* of the *strata* descending inwards, and from all which is observed in the neighbourhood, may be seen very clearly what has happened on this part of the bottom of the ancient sea. A great *subsidence* has taken place between this mountain and another parallel ridge called the *Cleberg*, the interval thus produced being a *combe*, which rises up to the top of the mountains, and is very deep in the lower part. The name of *Trifft* (or drove) is here given to *combes* of this kind, because the cattle are driven up them to the com-

mons

mons on the mountains. We ascended to a cert height by this *combe*, which it is impossible to con to any use, because it is too much covered v *blocks* of a *sand-stone* still harder than that of quarry, and overspread with lichens. Hence went on the *Cleberg*, which rises and extends it over a part of the mountain wherein the *combe* ter nates; this part is called *Steinberg*, (the *stone-mo tain*;) its soil is of *sand*, covered with *peat* of li depth; and it is strewn all over with *blocks* of same stone.

198. Beyond the top of the *combe*, two eminen rise on the ridge of mountains, in the lower par which are the quarries of mill-stones. It is higher part of the mountain that bears the name *Cattenbül*; and on reaching it, we saw, though m disfigured by time, all the phenomena which h been described by M. Hollman, as well here, as many other places where *surturbrandt* is taken u the same manner. On this part of the mount excavations have been made to arrive at the be the substance, which is believed to extend over whole summit: a thick bed of *sand*, covered v peat and with heath, is first cut through; below are found *strata* of *white clay*; and the latter immediately on the *surturbrandt*, which, as guide informed us, is between 30 and 40 feet thickness. The sides of the excavations whenc had been taken having been washed down by rains, nothing was to be seen in them except sa

but the guide, who had brought a spade, digging at the bottom of the slope, laid open the section of the *surturbrandt*, and from him we obtained information respecting what lay at too great a depth to allow us to see it. The *surturbrandt*, in the upper part which we saw, was a blackish combustible earth, resembling pulverized *peat*: but lower down, it has more solidity; and at the bottom is found much wood, of a dark colour, and in various states, the greatest part of it being yet ligneous; but other pieces, in which however the fibres are still discernible, are become so friable as to be easily broken in the hand. We found some scattered fragments that had been exposed to the air ever since the work in this spot had been abandoned; they had separated into laminæ, which, however, were still held together by fibres, and retained some flexibility; but it was not difficult to break them. Our guide lighted a fire with some dry sticks collected from the neighbouring bushes, and when it was fully kindled, he threw into it the fragments of this wood, which we had found scattered on the hill; these burnt as readily as the sticks; and when he had thus made a large fire, he dug to a greater depth in the *stratum*, and took out of it pieces of the buried wood, which presently burnt also; at last he laid on the fire a heap of the blackish earth; a longer time elapsed before this would kindle, because it was damp; but when it began to burn, it emitted a smell familiar to all who have lived in the countries where *peat* is used, for this substance is really *peat;* and the whole heap was soon consumed.

199. This bed of *surturbrandt* must therefore have been a *peat moor*, but not one of those which have been formed on the continent since it has existed; for at this height above all the circumjacent country, no cause can have spread over the peat so great a thickness of *white argillaceous strata*, the latter being themselves also covered with the heath *sand*, over which are scattered the same stones that are found on the *Steinberg*. On this subject, therefore, I shall here state my own opinion, because, in the sequel, it will be found to receive support from the other circumstances elsewhere accompanying the same phenomenon. I believe these beds of *fossil peat* to have the same origin as beds of *coal*, both having been *peat-mosses* on *islands* produced in the ancient sea by the earliest of the catastrophes so frequent on its bottom; which islands afterwards *sinking*, in consequence of other catastrophes, passed, but at different periods, beneath its waters. During a long time, the liquid of the sea possessed ingredients proper for *mineralizing* the *peat* under the form of *coal*, on the beds of which substance many *stony strata*, of different kinds, were subsequently formed; but its *vegetable* origin is always manifestly shewn by the *plants* of various species found in the *stony strata* that immediately cover it. The *peat-mosses* formed on *islands* which sunk at a later period, when the liquid no longer possessed this *mineralizing* faculty,

culty, were covered likewise with *strata* of a different nature; but in these, the *peat*, and the *wood* beneath it, are found with little alteration.

200. I have mentioned two eminences which rise on the mountain of *Cattenbül;* as these eminences were both covered with wood, I judged them to be of a nature different from the rest of the summit, where nothing grew but heath. We went first towards the smallest, which rose only 30 feet above the rest of the soil; and at its foot we found the same *basalts* as on the *Dransberg*, with the same *polyedrical* wedges, and *balls* which had fallen out of such as were broken. The other eminence, at some distance from this, was the highest of the two, and we ascended a steep part of it at the extremity nearest to the lower soil; the basalts were here covered with moss, and the trees extended up the slope. On gaining the summit, I found it to resemble those of all the eminences which I had formerly observed in my travels in the *Sollinguer-wald*, (forest of *Sollingue*,) where the soil of the woods consisted of loose *basalts* covered with moss. These two eminences on the *Cattenbül* extended behind into a forest.

201. The interval between these eminences is of a similar nature to the rest of the summit of the mountain; and here principally the ground had been opened to a very great depth for the purpose of taking out either the *surturbrandt*, or the *white clay*, which covers it under the superficial *strata* of a yellowish

white *sand*. It is of this *clay*, mixed with the *sand* in a certain proportion, that the famous *Hessian crucibles* are made, which so well resist the fire. The ground had not been opened in search of the *surturbrandt* beneath the two eminences; so that we could not learn whether that substance lay here under the *basalts*, as we afterwards saw to be the case on the *Meisner*. M. Von Harnstein's father had caused the *surturbrandt* to be worked chiefly for the purpose of making *alum* of another *stratum* which found below, and of which the earth, when brought out on the slope of the mountain, was calcined with the wood taken out of the *surturbrandt*: this earth after calcination, was for some time exposed to the air; it was then lixiviated; and the necessary ingredients being added to the lixivium, the *alum* was crystallized.

202. We returned from this excursion at 2 o'clock, and having again accepted the very obliging hospitality of M. Von Harnstein, we set out at half past 4 for *Gros Almerode*. The Chief Ranger, M. Germann, sent one of his servants with us as a guide; because it would have been impossible for us otherwise to find our road across these mountains, which are covered with forests: we were early enough to have completed our journey by day-light, if we had proceeded like other travellers; but we stopped too often by the way, to make observations, and this brought us into some difficulties. We first reascended the *Steinberg*, beyond which we went down

into another valley; and we afterwards successively crossed several other ridges of mountains, travelling the whole way through woods, and examining all the rocks near which we happened to pass: some of these consisted of *sand-stone*, some of *lime-stone;* and on observing the situations of their *strata,* we could never perceive that either the *direction* or the *inclination* of these had any reference to the exterior form of the ridges; so that both the Baron and myself were of the opinion, that it was impossible to examine these mountains attentively, without being convinced that they had become such in consequence of great catastrophes and dislocations of *strata* originally horizontal.

203. These observations had taken up so much time, that night overtook us in the woods, and the sky being unluckily clouded over, no stars were visible; thus our guide lost his way, and we came into a space so much covered with *blocks,* that we could not advance without great danger both to ourselves and our horses. We then proposed to kindle a fire with the assistance of the flint and steel used by our guide in lighting his pipe, and to remain till morning in the spot where we then were; but he, feeling that his reputation would suffer if we did not continue our journey, begged us to wait for him a little, and set out to reconnoitre the country: after some time, he returned to us with great joy; he had ascended an eminence, on one side of which he had smelt fires of the dust of the *brown coal,* usually burnt for the pur-

pose of getting rid of it, on a hill near *Gros Al* *rode;* and he assured us that he should be able lead us back into the road, if we would follow h on foot, holding up our horses by their bits, and a vancing very slowly among these mossy *blocks*: tru ing to his direction, after some time we regained t road, and reached *Gros Almerode* at 10 o'clock night.

Aug. 28th. We spent some time this morning i viewing the manufactures of crucibles, and of t other utensils of terra cotta, which are made at *Gr* *Almerode* of the same white *clay*, mixed with the sa found on many parts of these mountains; and w then set out on foot for the *Meisner* with a guide be longing to the place. We were not fortunate in th weather, for while we were upon the heights, rai came on, and interrupted our observations; howeve we observed enough to resolve some riddles hithert very perplexing to those who had seen on the summ of these mountains an immense bed of *vegetables* c vered with *basalts*, which, though with reason cons dered as *lavas*, had yet not consumed them. It wa chiefly to this object that Dr. TAUST, in his letter t Mr. De la Trobe, had been desirous to direct m attention; but the view of this mountain alone wa not sufficient to furnish the explanation of it.

204. Generally speaking, no question respectin the form of mountains of any class can be determine unless many mountains of every class have been ex

aminec

amined: for this reason, as I had formed for myself a very extensive plan of observations, I forbore, at the time, to publish those which I had made on this mountain, or even to form any judgment concerning its phenomena, contenting myself with observing, and taking notes. It is only by repeated investigations, in different places, of the same phenomena, and of their local circumstances, that the essential characters of each can be truly determined, so as that one may not be connected with another by coincidences merely accidental. I have therefore travelled much since the year 1782, but I have forborne publishing the observations made in my journeys, waiting till I should have completed these observations according to my original plan; in order that I might have time as well to fix my own judgment respecting the causes of the principal geological phenomena, as to point out those causes in my descriptions. This I have begun to do in the 3 Volumes of Travels which have already appeared; and in the preceding part of this Volume also I have followed the same course.

205. The great general object which is demonstrated by these observations, and will be proved by new facts on the road from *Gros Almerode* to Mount *Meisner*, is that scarcely any of the *strata* composing the accessible mass of our continents are to be found in their original situation; that they have all undergone *fractures, subsidences,* and *angular movements* of their separated parts; and that the *mountains,* with the *vallies* between them, and the *plains* on their outer

side, have been formed, in this manner, of *strata* originally *horizontal* and *continuous*; of which it is a particular proof that, among the masses of *strata* most broken and inclined, there are some that contain the exuviæ of many successive tribes of *marine animals*. Moreover, that all these catastrophes took place on the bed of the sea is shewn by the new *strata* with which the ruins of the more ancient have been covered. Of this we must never lose sight, because it is the summary result of facts; as will farther appear in the course of these Travels.

206. With respect to the *volcanic* phenomena intermixed in some places with those which I have just pointed out in the *strata*, it is likewise evident that, on the bed of the ancient sea, there were *volcanoes*; many of the *lavas* of the latter being now found covered with *lime-stone strata* containing *marine bodies*, as these also are, in several places, with *strata* of *sand-stone*; instances of which I have described in my first Travels published in 1780, as well as in my last visit to *Dransfeld*, above related. Now, as it was on the bottom of the sea that these *lavas* flowed, when they overspread the *peat-mosses* of the *sunken islands*, which were already covered with other kinds of *strata*, they could not consume the *peat*, though it was vegetable and combustible, because it was under water. It is principally around the *volcanic crowns*, as I have called them, formed by the lower parts of *lavas* flowing from a *cone* which afterwards *sunk*, that we find the *lavas* thus covered by new *strata*. Now

if even the more ancient strata, that had been overspread by a part of the *lavas*, were involved in the catastrophes which occasioned the *sinking* of the cone, that part must have disappeared in the *vallies* resulting from the subsidence, and the other parts of the same *lavas* must have remained on the heights above. We shall find this to be the case on the *Meisner*, and on the *Robelsberg* in the same *valley*, as well as on the *Cattenbül* near *Münden*; for it appears very evidently, from the state of the *strata* on the borders of great *vallies*, that such *subsidences* have there taken place, as may very well have swallowed up *volcanic cones*, in addition to all those huge masses of *strata* with which these vacancies once were filled. I have given the first place to the above explanations, in order that my readers may be afterwards more disposed to fix their attention on the phenomena themselves.

207. In going towards the *Meisner*, we proceeded some way along the road to *Weissenbach*, by the side of a brook flowing in a narrow valley. On our left we had the very rapid slope of a mountain, being the continuation of that which we had descended in the dark, the preceding evening, towards *Gros Almerode*; it was entirely covered with *blocks*; but they were all overspread with mosses or lichens, so that we could not distinguish their nature. We stopped however to make inquiries on this subject at a mill, below a part of the slope on which we had observed vast quantities of these *blocks*; and some broken

pieces of them being shewn to us, we found them to be of the same yellowish *hard sand-stone* as most of those which, since our departure from *Hastenbeck*, we had observed on mountains of another kind.

208. The mountains on the opposite side of the *valley* had quite a different appearance; their foot being bordered by hillocks, extending across the road in several small ridges. On the side on which we ascended these hillocks, they all presented abrupt sections, wherein we saw the nature of their *strata*. Those of the first ridge were of foliated *lime-stone*, descending rapidly towards the opposite side, and shewing their abrupt section near the upper part of the side on which we approached them. In the second ridge, the *strata* were of *sand-stone*, with the same *inclination* and the same *direction* as the preceding. After we had crossed this ridge, we quitted the *Weissenbach* road, and turning to the right, went up a *valley*, towards the higher part of which we gained sight of the summit of the *Meisner*. We still continued to proceed over ridges of small hills, successively rising above each other, and presenting to us, as we ascended them, the *sections* of their *strata*, on the *planes* of which, inclining rapidly inward towards the foot of the mountain, we afterwards descended. In some parts, where the road was cut to a considerable depth, we saw that the inferior *strata* were of foliated *lime-stone*, and that above these were *strata* of *marl* also foliated, alternately red and blue.

209.

209. After having passed over the masses of *strata* which, by their ruptures and the angular motion of their separated parts, have formed on the base of the *Meisner* these ridges of small hills, we entered a large vale in which stands the village of *Jüngsterode*, whence we began to ascend the body of the mountain itself. To a considerable height, we found *blocks* of the same kind that had hitherto prevailed, lying on the same strata of *marl* which compose the small hills; but higher up, these blocks were mixed with some of the *basaltic wedges*. On our left we had a great projection, beginning almost from the top of the mountain, and exhibiting only a vast heap of blackish fragments, which might have been taken for *basalts*, had not their form been different. We approached the foot of the slope, and on breaking some of these stones, we saw that their colour was merely superficial, and that they were the rubbish of a *limestone* apparently similar to that of the small hills which we had just crossed. At last, we ascended a slope entirely composed of *basaltic wedges*, larger than those on the *Dransberg;* but before they became so abundant as entirely to cover the ground over which they were spread, we saw, in many places, *sections* of *strata* of *sand-stone*.

210. If we stop for a moment to consider in one point of view all the circumstances which I have described on the road from *Gros Almerode*, together with the appearance of the *Meisner*, it is impossible not to perceive, in the whole, the most striking cha-

racters of the catastrophes indicated above; particularly it is evident that there have been great *subsidences* around all this side of the *Meisner*, which from that cause alone has become a *mountain;* how far its declivity extends behind will soon be seen. Thus the *basalts* on its summit cannot have proceeded from any of the causes which have been in action on the continent since the latter has existed. These *basalts* must belong to a *lava* that originally flowed from a *volcanic cone;* but the cone itself has disappeared in the large vacant space of which I shall give a particular description.

211. Just as we arrived at the foot of the above mentioned slope of *basalts*, we were overtaken by the rain, which obliged us to ascend it hastily, and take shelter at the house of the *Steiger*, or director of the works in the gallery opened on this side towards the bed of *surturbrandt*. The *Steiger* conducted us into this gallery, which, being near the village of *Bransrode*, is called *Bransrode Stoln*. The side of the mountain has here been pierced almost horizontally, a small ascent only being allowed for the discharge of the waters issuing from the sides and roof. The gallery has thus been carried on till it reaches the bed of *surturbrandt*, exhibiting the first vestiges of the catastrophes which took place in the mountain itself. The Steiger gave us the following account of the strata intersected by this gallery: 1. It was necessary to advance 12 yards through the slope of the loose *basalts;* which could not be effected without

props. 2. The first *strata* thus reached were of *lime-stone*, strongly *inclining* inwards in the mountain; and these were cut through to a length of 72 yards. Beyond these *strata* were found others of *white clay*, which are very soft to the touch, and must evidently have been formed over those of *lime-stone.* After having proceeded many yards in this *white clay*, three large *blocks* of *primordial stones* were found buried in it, in the same manner as similar blocks are frequently met with in the *peat-grounds* in *Mecklenburg;* and at this point the gallery was divided into two branches, for the purpose of leaving the *blocks* to support the clay. 4. Lastly, the *surturbrandt* is entered at a level about 10 or 12 feet below that of its upper part; from this point it is worked upwards, and we proceeded along some of the galleries.

212. According to the various states to which this vegetable mass has been reduced, its different parts are distinguished by different names. It is worked here, not for the sake of the *wood* contained in it, but because the upper part of the bed itself is compact, and approaches very nearly to the nature of *coal:* in some places, it resembles *jet* in its fracture; but it is lighter. I do not think that this change can be ascribed to the heat of the *basaltic lava*, for it will be found not to have taken place in a similar bed covered by *basalts* in this same valley; I rather consider it as a commencement of the *mineralization* of the *peat* into *coal.* Other parts break with some noise when crushed in the hand; these are again a

kind of *coal*, composed of laminæ, some of which are covered with *pyrites*, as is the case with certain *coals*; and this is far from being a sign of *combustion*: in some parts of *North Holland*, I have observed the same circumstance with respect to *peat*. The degree of hardness of this substance is known by the noise that it makes when broken in the hand. The bed is worked only for this upper part, which is about 4 yards in thickness; below it, the substance is of a lighter colour, and may be broken in the hand without noise: it is *peat*, little changed, and is found to contain pieces of the trunks, branches, and roots of *trees* in great abundance; but here these are not valued; and this part of the bed is used merely to fill up that from which better materials have been extracted, in order that the wood employed for props may be removed to the place where the work is actually carried on.

213. The bed is everywhere worked up to its *roof*, immediately under which lies the best *coal*: we saw this roof in many parts; it is formed by a stratum of foliated *sand-stone*, varying in thickness; and on this lie the *basalts*. Another symptom is here seen of the catastrophes undergone by the mass of *strata* on which this *peat-moss* lay, some time even after the whole had passed beneath the waters of the sea. In this mass there are *ruckens*, or *fissures*, passing through all the *strata*, as is the case in beds of *coal*, and in the mountains containing mineral *veins*; and on the opposite sides of these *fissures* all the beds of

surturbrandt have changed their *relative level* several feet. The *fissures* are from 1 yard in breadth to 4, and are filled with *basaltic* matter, which must be pierced through when a *rucken* occurs; and the substance found beyond it is always different from that forming the side first approached.

214. Another gallery had been opened on the same side of the mountain, in a part where there were no *basalts* on the slope; the work had been under the direction of the same *Steiger*, who gave us the following note of the *strata* through which it had passed, a small declivity being always allowed for the discharge of the waters. 1. *Sand-stone*, 40 yards. 2. Strata of *lime-stone*, 60 yards. 3. A stone which the *Steiger* called *liver-stone*, 8 yards. 4. Strata of *lime-stone* again, 60 yards. 5. *Clay*, 16 yards; and beyond this lies the *surturbrandt*. On the opposite side of the mountain, at a league's distance from this, another gallery, which had been named the *Firbach Stoln*, was then carrying on; but the *Steiger* told us that the *sand-stone* was not yet cut through these, and that he believed it would be a long time before the *surturbrandt* would be reached.

215. The rain being nearly over when we came out of the mine, we walked with the *Steiger* up to the summit of the mountain, from which we looked down over a very wide tract of country, consisting of hills and plains. On the summit was a horizontal space, whence, on the side opposite to that of our

ascent,

ascent, the mountain extended to a very great distance with a gentle slope, the whole of which was in pasturage: the *Steiger* told us that to walk round it would require full six hours, and that it afforded fodder to the cattle of 80 villages or hamlets. On the side where we had ascended, this part of the mountain was abruptly cut down; and below it we saw vast spaces in which the *volcanic cone* might probably have sunk, while still beneath the waters of the sea. In particular, we had within our view part of a very beautiful valley, through which the *Werra* flows to *Münden*, where, as I said before, it joins the *Fulda*, and the *Weser* is formed by the union of these two streams.

216. I had much pleasure in finding in great profusion, on the rich turf of this mountain, a plant which I had never happened to see since I had quitted the neighbourhood of *Geneva*; this was the *Dianthus superbus*; a pink very properly so named; for nothing can be more elegant than the capillary segments of its petals, which are green at the base, and above of a beautiful rose colour; it is also one of the most fragrant of flowers. I took up a plant of it with a ball of earth at its root, and carried it in this state as far as *Cassel*, where I put it into a pot; and having hired a chaise at that place for the rest of my journey, I preserved the plant with its flowers till I reached *Windsor*, where I planted it in the turf of my garden: it flourished in that situation many years; its stalks indeed decayed, but it threw up new shoots

in the spring, and formed every season a larger tuft, till at last it was killed by a very hard winter. This is the common fate of mountain plants, when carried down into plains, and, to speak more generally, of those of all cold countries, when transplanted into climates which are milder, but where the winters are sometimes very severe; in their native places, these plants are preserved by being covered the whole winter with snow. After we had concluded our observations on the *Meisner*, we returned to *Gros Almerode*.

Aug. 29*th*. Baron Von Reden and I were now to separate, which we did with much concern on both sides; for having made many excursions together, the great congeniality of our sentiments and tastes had united us in a very sincere friendship, and it seemed to us both that we were now parting for the last time; so indeed it proved; for the Baron died a few years afterwards, and I regretted him very deeply.

217. At *Gros Almerode* I hired a horse and a guide, and set out for *Cassel* at half past 10. At first, the road ascended between two ridges of mountains; and for some way I followed the foot of those on the right, where here and there I saw sections of thick *strata* of white *sand-stone*. The mountains on the left, which are the continuation of the *Meisner*, but not so high, had a different appearance. I had been told that among these there was a mountain

called

called the *Robelsberg*, containing another bed of *su* *turbrandt*, which was covered also with *basalts*: went up to its foot, and leaving my horse at a village, I ascended to its summit, where I found th same *basalts* as on the *Meisner*, that eminence, wit the whole extent of its slope, being here within m view. The part of the mountain composed of thes *basalts*, which is that properly called the *Robelsberg*, rises to a considerable height, and is abruptly cu down towards the valley, as are also the strata beneath it; this is the case particularly with the bed o vegetables, which is about 60 feet in thickness, and lies almost immediately under the *basalts*. The *Robelsberg* slopes down behind to a great distance, lik the *Meisner*, and like the eminences of *Cattenbü* and *Dransfeld*: a large space on its surface has bee greatly disturbed, but is now again covered wit grass.

218. The section of the *bed of vegetables* is covered with the rubbish of the parts above it, an cannot be arrived at any otherwise than by opening through this rubbish, a passage supported by suc pieces of wood as are used for *props* in mines. Ther are *galleries* of this kind at different heights, leadin to different parts of the bed which are worked; I desired to be conducted into the highest gallery, as being the nearest to the *basalts*, in order to see whethe here, as well as on the *Meisner*, the *peat* had in thi part undergone the change which assimilates it t *coal*; but I did not find that this was the case, thoug

her

here also I came to a place where it was separated from the *basalts* only by a certain thickness of *strata* of foliated *sand-stone*. The whole of this upper part consists merely of a brown powder, containing some concreted masses, which are taken out to be burnt in the manufacture of *alum*, while the powder itself is consumed on the spot in heaps, as the least troublesome manner of disposing of it: some of these heaps were burning when I was there, and emitted a smell exactly similar to that of *peat*. In the lower galleries, besides the compact *peat*, is found, as in *peat-mosses*, much *wood*, consisting of branches, trunks, and roots of trees; I saw heaps of these afterwards, near the *alum* works, where they are used, together with the above hard masses of the *peat*, in baking a kind of earth, the situation of which I shall presently describe. This bed of *fossil peat* has been worked more than a century; and the substance taken out of it not being of so much value as to be worth the expense of using much wood for *props*, when a gallery has been carried on far enough in a certain direction, and another is to be opened for the advantage of shorter carriage, the props are removed out of the former gallery, and are employed in the latter. The *roof* being consequently left here unsupported, the *basaltic* stratum has sunk in many parts; and thus the above disorder has been produced in its surface, evidently shewing how small a thickness of *sand-stone* there is between the *peat*, and the *basaltic lava*, which is all divided into fragments.

219.

219. It is during an equally long period that *alum* has been made in the valley from *strata* of an aluminous earth, which are found along the foot of the mountain. This work was carried on at present near the village of *Joannes Viesen*, and was called *Alaunwerk Ruelberg*. The mountain had been here attacked on the side of a projection, which is about 40 feet high, and is composed of blackish argillaceous sand, covered with a white argillaceous sand containing blocks. This projection is cut down from top to bottom by the workmen, who, after having removed the upper part, select from the rest such masses as they know will furnish most *alum*, and bake them in fires made of the *wood* taken out of the *fossil peat*, with which they mingle some of the *peat* itself, that these masses may not fall down between the pieces of the wood; when a heap is consumed, the masses are left for some time exposed to the air, before they are lixiviated with the addition of the ingredients necessary to produce the crystallization of the *alum*.

220. In the road from hence to *Cassel* I again observed great effects of the catastrophes which, in this region, have been undergone, as well by all the *strata* as by the *basaltic lavas* spread over the surface. I passed first through a valley of the most beautiful rural aspect, wherein flows a brook which, near *Cassel*, falls into the *Fülda*. Great quantities of *blocks* are scattered on the slopes of the mountains bordering this *valley*, and likewise on its bottom, where I again saw *lime-stone* rocks, the *strata* of which dip

inwards, and present their *section* at the top. This is a circumstance common in many *vallies;* and it shews to what kind of catastrophes they owe their origin: in the *subsidence* of the *strata* from which this valley resulted, some masses remained higher than the rest, and the surface was afterwards levelled by the gravel and earthy particles spread over it during inundations. Here the rocks belonging to the sunken *strata* are of *lime-stone;* while most of the scattered *blocks* are of the same *hard sand-stone,* of which so many have already been mentioned in other places.

221. As I approached the village of *Ober Kaufungen,* I saw that the small stream, which had hitherto flowed through meadows, had its bed covered with large *blocks,* because, having acquired a greater declivity, it had washed away the *sand* from between them: this *sand,* which lies also on the slopes of the mountains on the right, is the common *heath-sand;* and it is covered with heath, wherever that plant has not been destroyed by cultivation. Here and there appeared rocks belonging to the stony strata of the mountain; for some way, these were of a very red *sand-stone;* but after I had passed an inflexion about 100 paces in breadth, I found strata of a very white *sand-stone;* and all these strata inclined strongly towards the interior part of the mountain. The character of the catastrophe which produced this *valley* is clearly indicated by the *strata* of *lime-stone* rising in rocks on its bottom, by the change in the colour of

those of *sand-stone* at the same level on the oppo sides of a rupture, and by the inclination of the latt strata towards the side farthest from the *valle* After having passed *Nieder Kaufungen*, I saw *wedge* *shaped* and other *prismatic basalts* mixed with th rest of the stones on the slopes of the foot of th mountain, and on the bottom of the *valley;* whic shews that the *strata* had been covered with *basalt* previously to their *subsidence*. Below this, the valle opens into the plain contiguous to *Cassel*, where th *sand* is still mingled with blocks, but contains n *basalts*.

222. In the ivth. Vol. of my first Travels, p. 44 I have described a mountain above *Cassel*, calle *Carlsberg;* and I have shewn that it makes part o a *volcanic crater*, composed of the section of irreg lar strata of *scoriæ* little indurated, mingled wit *volcanic ashes* and *pumice-stones;* that these stra are spread over *porous lavas*, which rest on *lavas* d composed into *balls;* and that below the latter a *compact lavas*. All the details contained in tho travels, from *Dransfeld* near *Göttingen*, throu *Hesse*, and along the banks of the *Rhine* from Co *lentz* to *Bonne*, exhibit so many of the characte which absolutely belong only to *volcanoes*, name *scoriæ*, *porous lavas*, *volcanic ashes*, and *pumice-ston* that the *basalts* mingled with these must beyond a doubt be considered as *volcanic* also, and the variou situations wherein they are present found must ev dently appear to be effects of the *subsidence* of th

strat

strata over which the *lavas* had spread; the *volcanic cones* whence these lavas had flowed having *sunk in* and disappeared.

223. The rock whereon the town of *Cassel* is built still presents a monument of the catastrophe that extended over the whole of this country; for it belongs to the mass of *strata* through which rose the *volcanic cone*, whereof the *Carlsberg* is now the only remaining part: it terminates abruptly towards the plain; and the road down to the latter being cut on its side, the *strata* are there very distinctly seen; they are of *lime-stone*, and, inclining inwards, they descend under the superficial soil.

Aug. 30*th*. I set out from *Cassel* by the *Frankfort* road, along which I proceeded for some time. I have described this road, p. 506, in the Volume cited above; but I now observed it with eyes more experienced in geological phenomena. The soil of the plain extending from *Cassel* to *Wawern* is a yellowish argillaceous sand containing *blocks* of the kind of which I have long had occasion to speak; and this soil is so thick, that, though in many places it had been deeply cut to soften the declivities, I could but once perceive the *solid strata*, which there were of *sand-stone*.

224. Before I arrived at *Wawern*, I crossed the *Eder*, a small river which winds through a large valley, and joins the *Fulda* above *Cassel*. Observing

that there was *gravel* on its bed, and on all the parts of its banks below the level of inundations, I quitted my chaise in order to examine this *gravel*, which I found to be composed of a great variety of *primordial stones ;* namely, *quartz* of different colours, very fine *jasper*, hard *schisti*, and *wacke* likewise of different colours ; and as none of these stones appear on the eminences in any part of this country, I judged that they must have been contained in the soils intersected by this river, which has not a long course: after I had passed *Wawern*, this conjecture was confirmed.

225. As the large valley, along which I proceeded, has many inflexions, the road is occasionally shortened by being carried over the foot of the hills ; and as it is cut to some depth in three promontories descending from the highest of those eminences, they thus present their section towards the traveller : in the first I saw *strata* of *red sand-stone*, covered with a thick bed of *sand* of the same colour ; the second, which was near this and very high, shewed only strata of *yellowish sand*, with none of any *stony* kind appearing under them ; the third promontory consisted of a *grey earthy* substance, completely filled with the same *gravel* which I had seen on the bed of the river, the masses in the hill being *rounded*, as I had observed with respect to those lying in the course of the water. What convulsions must have been undergone by all the *strata* during the *subsidence* whence the *valley* resulted, to have thus brought to the same

level

of stone, with fragments of *grey wacke* intersected with veins of quartz. If the road had not been cut so deep, I should not have known what lay under this interesting *gravel;* namely, *strata* of the *red sand-stone,* strongly inclined inwards, and presenting their abrupt section towards the *Lahn.* Here and there, I came to spaces where the surface consisted of *yellow sand* without *gravel;* but in one of the sections, I saw that this covered the *red sand* which was full of gravel. At last, I passed over a large space where the surface was wholly composed of the common *heath sand,* mixed with some of the fragments of *white quartz,* which almost everywhere accompany it.

229. In one of the spaces where the red *sand-stone* was covered only with the sand mingled with gravel, I crossed a small ridge, several yards in breadth, which consisted of a *basaltic lava.* Looking then around me, I found I could follow this *lava* with my eye through the fields, as the large root of a tree may be traced under the grass; and at the distance of a quarter of a league, I saw it terminate at a woody hill, whereon stand the castle and village of *Stauffenberg.* This eminence, which thus evidently has been the source of the *basaltic lava,* is encompassed by the *strata* of *red sand-stone,* as is the case with several others in this part of the country, described in my first Travels. Beyond *Stauffenberg,* the superficial *red sand* is full of *blocks* of the *hard sand-stone,* and the *sand* itself

still contains the above mentioned *gravel*, in greater or less abundance in different places. As far as *Giesen*, the road is gravelled with fragments of *lava*. Between this place and *Butzbach*, where I staid till the next morning, the *strata* of *lime-stone* become prevalent; but *lava* is used in some places to gravel the road.

Sept. 1*st*. Though it was my design this day to proceed to *Friedberg* on the high road to *Frankfort*, I turned off from that road to *Zierenberg*, the seat of Baron VON DIEDEN which lies among the hills, at the distance of some leagues on the right. This gentleman, with whom I had had the honour of being acquainted during his residence in *London* as Minister from the King of *Denmark*, having heard that I was travelling in this country, had been so good as to invite me to take *Zierenberg* in my way; and I accepted his invitation with great pleasure, having spent many agreeable hours in his company and that of the Baroness.

230. I set out early from *Butzbach*, and passed through the villages of *Niederweisel*, *Pauerbach*, and *Langenhain*. In this road, the superficial soil changed from *red* to *yellow*, still, however, covering *strata* of *red sand-stone*, as I saw in the sides of the road; afterwards the soil became *grey*; and it then began to cover *schistus*. This grey soil was full of large fragments of *white quartz* and *granulated quartz*; but between the two last villages I

chiefly saw masses of the *breccia* of which I had already observed some fragments on the hills near *Marburg*; some of these masses were of a sufficient size to have been sawn into slabs for tables; it would certainly be attended with great expense to convert them to this use, for the *breccia* is extremely hard; but the masses of *quartz* which are contained in it are of so many various colours, that the beauty of such tables would be very great.

231. We are now near a *schistose* chain, of which both the external and internal state will presently be seen; but let us first stop to consider, the variety of the *strata* already described, resulting from changes at the same level of those which must have been originally deposited one on another; the state of all these *strata* of every class; the variety of the *blocks* and *gravels* of inferior *strata* scattered on the surface; and lastly, these masses and fragments of *breccia* disseminated at so great a distance from their origin. From the whole assemblage of the above circumstances, it is impossible not to conclude that this must have been a theatre of repeated revolutions of the *strata*, while still on the bed of the sea; and that the *schistose* chain is now uncovered, because, in the great *subsidence* whence resulted the vast *valley*, the *strata* of *lime-stone* and of *sand-stone*, by which the *schisti* were originally covered, slid down and abandoned them, while, in other parts of the same country, the strata of *lime-stone*, remaining upon them, are themselves exposed to view

in consequence of the fall of those of *sand-stone.* That the *schisti* and other *primordial strata* prevail beneath these two *secondary* kinds may farther be judged from the quantity of *blocks* and *gravels* of the primordial classes thrown out on the surface during the catastrophes. Moreover, the *breccias* prove that these catastrophes must have been often repeated; that the *primordial strata* were covered, during the earliest that happened, with their own fragments, which were subsequently formed into breccias by new *quartzeous precipitations;* that the *calcareous* and *sandy* strata were produced afterwards; and that the great catastrophes whence resulted the vallies between the ridges of hills did not take place until after the strata of *breccia,* as well as those which succeeded them, were consolidated; since they all underwent the same fractures and angular movements. This is an example of what may be seen in most mountainous countries; and many other instances of it will occur in the course of these travels.

232. The road to *Zierenberg* lies through a valley belonging to the first ridge of the *schistose* eminences, the *strata* of which are nearly *vertical,* and present their sections on the summits. When I had proceeded some way, I came to a promontory advancing from another ridge, and dividing the valley. It is on the extremity of this promontory, which, by the labour of man, was in ancient times separated from the rest, that the castle is situated: I arrived

there at an early hour, and had great pleasure in again seeing the Baron and Baroness; but the course of observations in which I was engaged did not permit me to remain with them long. I explained my views to the Baron, who having given me directions, and likewise ordered a guide to attend me that I might not lose my way, I spent the rest of the morning in visiting the objects which I had wished to observe in this neighbourhood.

233. I ascended two hills near the castle, and found them to be composed of a kind of *schistus* which had formerly much perplexed me in the *Alps*, and had been one of the causes of my comprehending nothing of the origin of those mountains: it appears externally to consist of sets of fibres; it separates into pieces which perfectly resemble the chips of oak in dock-yards; and on a near inspection of it in the places where it is found, the difficulty of distinguishing its *strata* is rendered so great by its numerous fractures, that I had not supposed it to be stratified. But now, being acquainted with the remarks and observations of M. de Saussure, I here distinctly perceived the *strata* of this schistus in the sides of the valley, where they are seen to be nearly vertical, and where they terminate at the summit with some resemblance to bundles of faggots. In some parts, where these *schisti* are more compact, they evidently appear to have undergone repeated catastrophes; the first shocks which they received are shewn by many small

veins of *white quartz* that intersect them; and these *veins* have themselves been broken and displaced, probably during the great catastrophe from which the *vallies* resulted.

234. After this walk, I returned to the castle, where I spent some hours in very interesting conversation. Having spoken of my observations on the *Meisner*, a nephew of the Baron's informed me that there was a similar stratum of *fossil vegetables* at *Westerwald*, in the principality of *Nassau Dillenburg;* and some years afterwards, I saw another in the country of *Brunswick;* this phenomenon therefore, though for the most part unknown in other countries, is not rare in these.

235. At half past 5, I set out from *Zierenberg* for *Friedberg*, passing for some way along the foot of the first ridge of mountains on its inner side, and afterwards crossing it to return into the plain. These mountains are covered with wood; and in some places appear the *schistose strata*, which strongly incline inwards, presenting their sections above. The lower part of the country consists of small hills, covered with a grey earth, mixed with gravel and larger fragments of *quartz;* and I saw nothing more of the *schisti.* The same soil continued as far as *Friedberg;* but by degrees the masses of *quartz* became less abundant, and at last I saw at the surface nothing but some fragments of a grey stone.

Sept. 2nd. From *Friedberg* I set out at 6 in the morning for *Frankfort*, where I spent the rest of the day. In the ivth. Vol. of my Travels, I gave a very particular description of the country which lies between these towns, and is so peculiarly interesting to geologists. There also I described the road from *Frankfort* to *Darmstadt*, but with few details, because I merely passed along it as a traveller; at present however, I went to *Darmstadt* in order to pay my respects to Duke Charles, now reigning Duke of *Mecklenburg Strelitz*, whom I knew to be at that city; and his accidental absence when I arrived at the Palace, gave me an opportunity of observing the adjacent country, in which I met with some very remarkable phenomena.

Sept. 3rd. I set out from *Frankfort* at 7 in the morning. I mentioned, in my former Travels, that I had not seen anywhere a soil more fertile than that on the hill of *Saxenhausen*, over which passes the road to *Darmstadt*; it requires no manure, and consists, to a great depth, of a *calcareous sand*, mixed with very small *sea shells*. But the same fertility does not extend to the slope on the *Darmstadt* side; for this, together with the neighbouring plain, is covered with *heath-sand*, having at its surface, in greater or less abundance, those particles of *white quartz* which I have already frequently mentioned, and which I have seen in this kind of sand over all the countries of the north of *Germany*; whence I have at last been led to imagine that these particles may be insulated *crystallizations* of *quartz*, produced in the ancient sea during the latest precipitations of this *sand*, which is also *quartzeous*.

Some naturalists have supposed the *sand* itself to consist of triturated *quartz*; but this is a mistake, as has been perceived by M. de Saussure, and as I shall have an opportunity of shewing in the sequel.

236. Between the villages of *Langen* and *Allerheiligen* begins a causeway which is covered with fragments, brought from a neighbouring hill, of a very hard stone, resembling *granite*, except that it contains no *mica*. As I approached *Allerheiligen*, I observed in the soil some *blocks* of true grey *granite*, of which there were great quantities along the houses of the village; I saw many also by the sides of the road; and near *Darmstadt* there was one so large, that it had been split with gunpowder for the purpose of removing it.

237. It was about noon when I arrived at *Darmstadt*; and on learning that the Duke was gone into the country, and would not return till the evening, I determined to remain at this place the rest of the day, and to avail myself of the opportunity to observe the neighbouring lands, as well as to see some persons whom I knew to be conversant with natural history and mineralogy. I took notice that there were several remarkable stones in the pavement of the streets; on inquiring whence these came, I was informed that the quarries were in the country, and I obtained a guide to shew me the way to them.

. . . .

238. The town is built on a small hill; my guide led me out of it on the highest side, and turning into a road on the left, he pointed out to me, at some distance, a rock, where he told me I should find one of the quarries. On arriving at it, I perceived it to be a very singular rock of *granite*, with small crystals and black *mica*, rising insulated on the sandy plain. This great mass was divided by fissures; some of these were regular and parallel with each other, and appeared to be separations of the *strata*; the others, which passed across the former, being irregular, and not everywhere intersecting them all, I judged to be only fractures. The whole rock was thus separated into angular fragments, and I found here a striking example of the manner in which *blocks*, and even rocks of *granite*, are *rounded*, by the decomposition of the *angles* of their masses. I perceived it first in some angular pieces that had been detached, and lay at the foot of the rock, surrounded with rubbish; for, on giving them a strong blow with an iron at the end of my stick, the angles fell off, detaching themselves with a concave surface on their inner side; and I thus produced *rounded blocks*, exactly resembling those which I had seen scattered on the plain, and possessing all the hardness of *granite*: a phenomenon similar to that of the *balls* lately mentioned as formed from *basalts*, when the decomposed angles are struck off from the mass merely by a blow. Those masses, which appeared externally in the upper part of the rock, were already rounded, without having changed

their place. In working this rock from top to bottom, for the purpose of obtaining masses of the stone for various uses, those at any considerable height are rounded by their fall; and the ground is covered all around with a coarse sand composed of the crystals of the *granite*, which, when detached by decomposition, are washed down by the rain-waters. Most of the masses separated from the rock being of too great a size to be easily removed, and larger even than is necessary for the various purposes for which they are intended, such as walls and pavements, they are split with gunpowder; many had been broken lately in this manner; and I saw around them some scales which the shock had detached from the harder part, and of which one surface was convex and the other concave. In my subsequent Travels will be seen more considerable examples of *blocks* rounded without being displaced, not only in *granite*, but in a *sand-stone* containing *marine shells;* and from a similar reason; namely, that angular parts are penetrated more easily than continuous surfaces by the causes of erosion or of decomposition.

239. But besides the *granite*, I had seen, in the pavement at *Darmstadt*, some stones of a quite different kind; these were brown, with whitish spots, similar to the *leucites* of ancient *lavas;* they resembled what is called *whin-stone* in *England*, which is probably volcanic. I asked my guide whence they came; he could not tell me; but addressing

myself to a person passing by at the time, the latt directed me where to find a man who worked i the quarries from which they were brought, and wh readily shewed me the way thither.

240. After I had crossed the space strewn wi crystals of the *granite* decomposed in the rock, no longer saw anything but the *heath-sand*, so fi and so pure, that, before it was fixed by vegetatio it had been raised up in *dunes* here and there by t winds. I found in my way a great many lar *blocks* of *granite* covered with *lichens;* a proof th no decomposition was taking place on their surfa After walking on for a quarter of an hour we ca to a forest called *Oberwald*, at the entrance of whi the ground begins to rise above the level of t plain, and has been opened in many places, in ord to take out the stone in question. As soon as entered the first quarry, I saw, beyond a dou that this stone was a *lava;* the sections around t excavation, which had been worked for a long tim were those of a kind of *strata*, not regul like the *strata* of *granite*, *schistus*, *lime-sto* and *sand-stone*, but similar to those of the *lav* around *volcanoes;* being tortuous and unequal thickness throughout their whole extent. The low of these successive *lavas* that had yet been reach were very compact, and were full of the *leucites* round bodies which I mentioned above, and whi were in general of the size of a pea; most of the were white, but in some places they were reddis

t

the upper *lavas* were more porous, and did not contain so many of these bodies; but cavities which had been occupied by them appeared in the sections and fragments: some of the strata approached very nearly to the nature of volcanic scoriæ; and M. Klipstein and M. Merke, whom I saw on my return to *Darmstadt*, (the former of which gentlemen had made a very interesting collection of the stones of this province,) both told me that they had no hesitation in believing the above to be *lavas*.

241. Advancing farther into the forest, my guide led me to a small insulated eminence, around which, on all sides, I saw quarries of the above stone; but the eminence itself consisted of that *granite without mica*, (the *sienite* of Werner,) whereof I had seen fragments on the *Darmstadt* causeway: it was from hence that this stone was taken for the causeway, which might easily be done, because the whole rock was full of fractures; but it is worthy to be remarked that on this kind of *granite* the actions of the water and the air had had no influence, though their effects on the neighbouring rock of *granite* containing *mica* have been already seen; the masses of this second rock had preserved all their *angles*, as well in their original situation, as when dispersed in separate *blocks*.

242. Respecting the relative period at which these *lavas* flowed, a judgment may be formed from the whole assemblage of the above monuments; this

period must have been posterior to the catastrophes which, in the extensive space between the mountains, left above the level of the ground *granitic* rocks of two such different kinds, though at so small a distance, from each other, since one of these rocks is surrounded by the *lavas;* but the *cones* whence the latter flowed sunk afterwards, during subsequent catastrophes; as is the case with regard to the *lavas* which I have described in *Hesse.* When I was on the Mount of *Sienite,* I saw the *lava* at its foot rising for a considerable way, like those in all that country, above the rest of the soil: I descended on this side towards the interior part of the forest, and crossed a space of some breadth by which it was separated from a large eminence where nothing appeared but pure *heath-sand;* and I found from my guide that no opportunity had occurred of discovering what lay beneath. Having ascended this new eminence to a certain height, I perceived that it was the foot of a mountain; and from what my guide told me of the stones which appeared at the summit of the latter, I comprehended that this stone was *granite.* I afterwards learnt that this mountain was the commencement of the chain of granitic and other quartzeous rocks bordering the fine country of *Bergstrass* from *Darmstadt* to *Heidelberg,* which I described in the IIId. Vol. of my first Travels: thus we find that this great chain begins, in the plain of *Darmstadt,* with two simple rocks, of different kinds of *granite,* at a very low level. How many repeated catastrophes of the whole mass of strata are indicated to us by these phenomena! In the evening I returned to *Darmstadt*.

Sept. 4th. I had the honour of seeing the Duke of *Mecklenburg*; and having passed the morning with his serene Highness and his family, I set out, after dinner, for *Mentz*. The plain of *Darmstadt* is considerably higher than that near the latter town, towards which I descended through woods by a gentle declivity. On reaching this low ground, I found it to consist entirely of sand, without any stones on the surface; so that I had little reason to regret being obliged to travel over it two hours in the dark; for I did not arrive at *Mentz* till 10 o'clock.

Sept. 5th. I took a boat in which I embarked my chaise, in order to descend the *Rhine* as far as *Cologne*. It is only 6 leagues below *Mentz*, near *Bingen*, that this great river enters into vallies; and there also begin the vineyards which produce the famous *Rhenish wine*. It is impossible to sail on this part of the river without continually experiencing new pleasure; I have described its picturesque beauties in the IIId. Vol. of my first Travels, for which reason I shall not again speak of them; but it was with a more experienced eye that I now beheld the geological features of the scene. At that time I described masses, forming interrupted mountains, in which I comprehended nothing; but at present, having been enlightened on these subjects by M. de Saussure's Travels in the *Alps*, all was become intelligible to me.

243. The *valley* in which the *Rhine* here flows has manifestly been produced by a great subsidence of the *schistose strata* that prevail in this country; but the parts remaining at a high level, and bordering the *valley*, have themselves experienced many ruptures and partial subsidences which have been attended by the *angular motion* of the parts thus divided; so that in sailing down the river, one pyramid appears to rise beyond another: when these pyramids are viewed laterally, either as they are approached, or as they are left behind, they are seen to be *sections* towards the river of chains of hills extending on their opposite side into the country; and it is on the terraces into which these *sections* are broken that, where the aspect is favourable, the *vines* are planted in slopes composed of rubbish. I stopped in the evening at *Boppart*, on the left bank of the *Rhine*.

Sept. 6th. I set out from *Boppart* at 6 in the morning. As I passed before *Coblentz*, I felt great regret that it was no longer the residence of M. and Mad. DE LA ROCHE, and Capt. TROSSON; remembering what assistance I had received from the former of these gentlemen, in my observations on the banks of the *Rhine* at its confluence with the *Moselle*, and from the latter, in the excursions which we made together over the *volcanic* mountains and plains of the country of *Treves*.

244. The period at which both M. de Saussure and myself made our observations was very favourable for the purpose of establishing, by monuments, several corresponding epochs in the *history* of the *Earth*, and in that of *Man;* monuments which human labour has since demolished, but from which we separately concluded, that (as it was expressed by M. de Dolomieu, who perfectly agreed with us) "no great number of ages has elapsed since "the earth was given up to the race of men by "which it is now inhabited." During the course of our observations, a greater progress was made in agriculture, in building, in the enclosure of alluvial soils along the shores of rivers and of the sea, than had been ever the case in any preceding period; and by this progress the traces of the *effects* of *natural causes*, connected with those produced by the different settlements of *men*, are in many places now concealed. It is therefore fortunate for posterity that certain states of things, which, at the very time when they were described, were on the point of being obliterated, have been recorded by observers, as has been shewn by many examples in the course of my Travels already published.

245. This remark has been here suggested to me by a change which I observed, as I passed *Coblentz*, in a spot where a palace now stands, but where, in 1778,

1778, I had seen a deep excavation: I described this excavation, and what was then to be observed there, in the ivth. Vol. p. 285, of my *Lettres sur l'Histoire de la Terre et de l'Homme;* a work which, though it corresponds throughout with its title, I generally mention by the shorter name of my *first Travels*. The monument of an epoch equally belonging to the *history* of the *continent*, and to that of the *men* who have inhabited it, was at that time open to view in the above spot, near the confluence of the *Rhine* and the *Moselle;* and this monument having been since concealed from sight, I shall now concisely repeat my former account of it.

246. The history of the continent was then plainly to be read in the differences which were seen, at different depths, in the alluvial soil here formed by the two rivers. As I have already said, a vast excavation had been made for the foundations and underground offices of the palace, and had been carried to the depth at which lay the first materials brought down to this spot both by the *Rhine* and the *Moselle*, while the torrents that form those rivers were still employed in clearing their channels in the mountains; at this depth, therefore, lay very large *stones:* but, in the sides of the excavation, the size of the *stones* was seen to diminish progressively from the bottom upwards, till at last they were reduced to small *gravel*, which was covered with a bed of *sand* from 4 to 8 feet in thickness; this latter accumulation indicating a period

when the two rivers, having terminated their ravages, had ceased to bring down anything in their inundations but the *sand*, which, in some parts, they still detach from their banks. Now in this spot had been discovered a monument determining the date of the commencement of the above period. There had been here a burying place of the *Romans*, who had dug, for that purpose, pits, of which many, on being opened, had been found to contain ashes, remains of bones, various sepulchral attributes and legionary stones. In one of the sides of the excavation, I saw the section of two of these pits; they had been sunk in the *gravel*, the small *gravel* closing them at the top. It is therefore since the well-known time of the abode of the *Romans* in this country, that the accumulation of sand has been formed here by the inundations of the rivers, which still cover these soils during extraordinary swells. Many other sepulchres of a similar kind, to the discovery of which nothing will ever lead, are probably buried under the *sand* in this plain on the banks of the *Rhine*; the above would not have been found, if the ground had not been opened to so great a depth; but the spot is now covered by the palace which has been erected on it; and unless I had happened to be here exactly at the proper time to observe and publish the account, it is most probable that all recollection of this curious fact would have been lost.

247. In relating the same journey, I also described the plain which opens on the left bank of the

purpose of repairing it: some of these *blocks*, which had been split with gunpowder, I clearly perceived, by the difference of grain and colour in the same *masses*, to have belonged to *strata*; yet no traces of any *strata* of this species appear externally throughout the whole country.

249. The ridge of hills that I first crossed is composed of *strata* of foliated *sand-stone*, which are seen to *dip* inwards, and of which the *direction* obliquely cuts that of the *hill*. I then descended into a very narrow vale, wherein were the *coal-pits*. Here I learnt that these pits were the property of the town; and I fortunately soon obtained information respecting them, which I found more intelligible than that of the colliers; for M. Winckelzeltz, the director of the works, having heard in the town that I had set out to observe them, was so obliging as to follow me to the spot. It is therefore on his authority, confirmed by the head collier, whom he called, and who traced figures on a plank with a piece of chalk, (the language in which I best understood him,) that I shall now describe the state of this *bed of coal*.

250. The *roof*, that is to say the immediate covering of the *coal*, is in this *bed*, as well as in all which I have anywhere observed, a foliated *argillaceous stratum*, with its laminæ covered with impressions of *vegetables*. Here therefore may be applied that very essential remark in Geology; that those

strata,

trata, which, from their nature, must necessarily ve been formed in a situation nearly *horizontal*, s is the case with these *argillaceous strata* containg *vegetables*,) and which yet are now found in ry different situations, have certainly owed this ange of state to *catastrophes*. Now it will be een how strange a catastrophe must have been unergone by all the *strata* of these *hills*, in order to duce this *bed of coal* to its present state.

251. The transversal section of this bed, as ched on the plank by the head-collier, was rly in the form of a capital M. That part of e bed which is represented by the side stroke on e left of this letter has been turned in such a manr as to have become nearly *vertical*, the *stratum* ntaining *vegetables* being now on the outer side, he part represented by the other side stroke is inied, retreating from the former; and this also has he *stratum* with *vegetables* on the outer side. One of these parts, with one of those represented by the two central strokes of the M, is in each of the *hills* which form the opposite sides of the vale; and the interval between these central strokes represents the vale itself. If the *fractures* and *inclinations* of the separated parts of the *bed of coal* had been regular, the section of the *argillaceous roof* would be designated by the latter strokes, which meet and form a V in the centre of the M; but there are only vestiges of it here and there; into such disorder has the bed been thrown, in consequence of the subsi-

dence which produced the vale; and where this is lost, the *coal* has nothing near it but a con mixture of stones of every kind.

252. The present coal-pits being in the vale colliers had arrived at the lowest point of those parts of the *bed* of which the section forms and had since followed them both laterally; these parts are not found to terminate every at the same depth, for the *bed* having been br the masses, thus separated, have undergone diff degrees of subsidence. I went down into o the pits; and the collier, who accompanied shewed me several places in which the *bed of* had been disordered in its fall by these parti accidents. Though the pits had been sunk great depth, the bottom of the two exterior pa the bed had not yet been reached; but these not at present followed downwards, being of considerable lateral extent.

253. Here then we have another interestin ample of the manner in which were produced with *vallies* between them; and hence appear mistake of those, who, for the formation o latter, have recourse to the insufficient agen *running waters*. Were it not for the *bed of* that it has been here found profitable to follow thing would be known of the internal state of twin hills, externally resembling many others, are not merely associated in pairs, but multipli

ri

ridges, and which, from the study of their surface alone, are found to indicate the same kind of catastrophes by the sections and situation of their *strata*. It was on the summit that this bed of coal was discovered at a very remote period, its section there being covered only with rubbish, and it has now been worked a long time: many others have been discovered in the same manner, as I have had opportunities of learning in various countries. At first the bed was followed from the top; but it was found dangerous to proceed very low in this direction, because, when the *coal* was removed, the sides were liable to crumble down on a sudden into the vacant space. Shafts and adits were then opened in the manner which is practised in *mines;* and the same caution is used in leaving or placing the necessary props.

254. The catastrophes, of which marks are in this place so visibly impressed on the superior *strata*, must necessarily have extended to the inferior also; for the latter were those that broke and subsided; and these huge masses could not have fallen into the *caverns* which occasioned their ruptures, without expelling the *expansible fluids* that then occupied those vacancies: now it was by these fluids, when rushing forth with a violence to which at present our globe exhibits nothing equal, that fragments, belonging to *strata* not seen externally in the spaces where such masses are scattered, were thrown out on the surface. This is the case with the masses

of *granulated quartz* in the neighbourhood of *Aix-la-Chapelle:* their original abundance here was such that they were used for building the walls of the town, and paving all the streets; they have been also employed in paving the causeways, of which I saw one, a league in length, in the way to *Liège:* yet their number does not appear to have diminished, except in the immediate vicinity of the places where some particular use has been made of them; for I observed a great many on the hills in my road, and my guide told me that they were brought thence in order to be cut into mill-stones.

255. On quitting the coal-pits, I took leave of M. Winckelzeltz, intending to return to *Aix-la-Chapelle* by a different road, in which he was so good as to direct me. As I approached the town, I saw on the right a hill, with a steep side, consisting entirely of *sand;* its name, *Loseberg*, implies the mountain of loose soil. The best road to its summit being from the upper part of the town, I set out by that way in the afternoon.

256. Having arrived at the brow of the steep face of the mountain, I descended one of its sides to the foot; the upper part presented a section, about 60 feet high, of very regular *sandy strata,* below which was a slope composed of their fallen materials; I walked along at the foot of this slope, where were lying such small hard bodies as had been contained in the sand, and had rolled down to the bottom;

tom; and observing among these a prodigious abundance of *marine exuviæ*, I ascended the slope itself to a part where I perceived that many of these had rested on the surface; they were white, but very well preserved; I picked up a great variety of species, *chamæ*, *ostreæ*, *cardia*, *pectines*, *turbines*, *neritæ*, *terebratulæ*, *glossopetræ*, teeth of the *dorado*, *porpites*, *orthoceratites* with their concamerations waved like parsley leaves, a piece of *petrified wood*, with a knot in it, full of the holes made by sea-worms, a rounded fragment of a *primordial stone*, which, as well as many of the *shells*, was incrusted with the *tubes* of *sea-worms*, and lastly, some fragments of *bones*.

257. On one side of the abrupt part, I saw these *sandy strata* (which, since they contain so great a quantity of *marine bodies*, must certainly have been produced on the bed of the sea in a position nearly *horizontal*) descend considerably on the side opposite to their *section*, in the front of which a very extensive *subsidence* of their mass has taken place; they have also been *broken off* and have *subsided* on both sides of the abrupt part; so that their slopes on these sides are properly taluses formed by the crumbling down of their loose materials. Ascending by one of these slopes, which was covered with a thin turf on sand, I found that the summit, where this turf was continued on a soil composed of small gravel, extended behind to some distance, with the same inclination as the *strata*. I advanced to the

brow of the abrupt side, and saw, that it consisted above of the section of thin *calcareous strata* covering the *sand* to the thickness of about six feet, and in great part transformed into *petrosilex*. The uppermost of these *strata*, probably in consequence of the actions of the air, exhibited only some concretions of *petrosilex* little connected with each other, in which I saw most of the *shells* that were contained in the abrupt section of the *sand* below them: I found there also a fragment of a *bone* belonging to the *tibia* of some large quadruped, and a piece of *wood;* and of both these the interior part was converted into *petrosilex*, and struck fire with steel. I would gladly have devoted much time to the examination of the whole of this summit, for it appeared to be extremely interesting. The turf was too thin to conceal the superficial soil, which consisted of sand mixed with *gravel*, wherein I saw fragments of *petrosilex* containing the same *marine bodies* as the *strata*, and of *primordial stones* similar to that which I had found in the sand, incrusted with the *tubes* of *sea-worms;* a proof that this *gravel* had been scattered here antecedently to the retreat of the *sea:* I have seen, in many places, among *fossil shells*, pieces of *gravel*, to which were attached, not only tubes of sea-worms, but likewise *ostreæ;* and of this I have given an example in my *Elementary Treatise on Geology*, p. 275.

258. It is therefore very evident that these *sandy strata* must have been formed in the *sea*, on the

ruins of *stony strata;* that they were there covered by the *calcareous strata,* which are now converted into *petrosilex;* and that all the *strata,* the lowermost included, afterwards underwent *fractures,* partial *subsidences,* and the *angular movement* of their separated masses. In the *subsidence* of the *sandy strata* on one of the sides of the principal eminence, a *mount* has remained, on which there is a *chapel.* Hence, perhaps, this town takes the appellation that distinguishes it from many others in different countries bearing also the name of *Aix,* but with various additions: *Aix,* which is a word derived from some ancient language, always denotes a spot where there is a *mineral spring;* as is the case at *Aix-la Chapelle.*

Sept. 9th. I set out at seven in the morning, intending to proceed this day as far as *Liège.* I described the road in the vth vol. of my first Travels, Letter 136: my observations having then been exact, I shall not here repeat them; but as, at that time, I did not include the *primordial strata* in the catastrophes which I perceived the *secondary* to have undergone, my conjectures respecting the causes of those catastrophes were imperfect, and I shall now supply the deficiency.

259. In crossing at first some other hills, consisting of *sandy strata,* as I descended one in which the road was deeply cut, I saw a large section of its mass, where the strata had the same strong in-

clination as the slope, and presented their upper *section* at the top of the hill; one of these *strata* was distinguishable from a distance, by the abundance which it contained of small *marine bivalves*, whitened by calcination, and become extremely brittle. This is a new example, in addition to the multitude of others that I have observed in various countries, of the important fact, which, in my preceding works, I have opposed to many geological systems; namely, that the *sands* extended in *strata* over such vast tracts of land are the product of the latest *precipitations* in the ancient sea; and that these *strata* had participated in the latest catastrophes of the *stony* kinds which lie beneath them, antecedently to the retreat of the *sea* from our *continents*.

260. It was raining, when I came down into the plain, so that I could not quit my carriage to view some objects which required a near examination. I passed several of the sandy hills, whence is taken the *lapis calaminaris*, so greatly conducing to the celebrity of the town of *Aix-la-Chapelle;* it being used for the purpose of converting *copper* into the best known *brass*, which is transported to a great distance, as are also various articles made of that metal. Opposite to one of these hills where men were then at work, and in the road to *Henry Chapelle,* I saw a rock wherein that road had been cut, and whence stones were taken for pavements; and this appeared to me to be at last a rock consisting

of the same *granulated quartz*, of which I had so long seen *blocks* dispersed on other soils; the section of its *strata* was towards the road; they were very distinct, and descended rapidly on the opposite side towards a small valley: I observed two other similar rocks on the same side of the road.

261. Near this spot, I afterwards saw, on the right, the eminence composed of *strata* of *chalk*, which I described in the Letter cited above, having considered it as an object very worthy of attention, because I had not seen any other *strata* of the same species on this side of *Luneburg*; although in the intermediate countries of *Westphalia* and *Lower Saxony*, vast quantities of the *flints* belonging to *chalk* are scattered on the surface of the *sand*. It was the observation of this circumstance which first suggested to me the idea, confirmed by all my subsequent observations, that, during a certain period, and on particular tracts of the bed of the ancient sea, its *liquid* became capable of *dissolving* the *chalk* which had been precipitated during an earlier period, leaving only the *flints* that had been formed in that chalk.

262. Part of the way from *Batisse* to *Liège* I travelled through fields, because the high road was undergoing repair; and here I again observed a great many *blocks* of *granulated quartz*. The base of the soil consists of some kind of *foliated stone*, which I saw here and there, but at a distance, in

some deep cuts, and which is covered with a great thickness of *sand*: I perceived also that the lower strata of the latter were of a very pure *white sand*; but that *gravel* was always contained in the grey or yellowish *sand*, which, in some places, lay on the surface. In the evening I arrived at *Liège*.

Sept. 10*th*. I set out in the morning for *Brussels*. If, when a traveller enters *Flanders* this way, he confines himself to the high road, a soil extremely fertile, and every where cultivated, will nearly put an end to his geological observations. I do not mean to say that this country is not entitled to the attention of a geologist; but it cannot be properly examined otherwise than by passing from hill to hill; and this I have never had an opportunity of doing. I again saw here great quantities of those irregularly shaped masses, which, because of their resemblance to the *grès* found in the forest of *Fontainebleau*, I had called by the same name, considering them as *concretions* formed in *sand;* for I had not yet seen them, either in *France* or in *Flanders*, except on *sandy* soils. But, from the beginning of my present Travels, I have acknowledged myself to have been mistaken in this respect, having since found the same masses on every kind of soil. I have besides explained that the irregular figures of these stones are produced by the unequal induration of their several parts, and the consequent unequal decomposition of their surface; but in various countries I have seen *angular blocks* of the same kind of stone. The hardest are a *granulated quartz*, with a very shining grain where broken; but from these there is a gradual transition to others of a duller grain, which however are also very hard; I have been told that, in some parts of *Flanders* they are used for mill-stones.

263. It has already appeared, and will be farther shewn in my subsequent Travels, that, in proceeding towards the south of *Germany*, *blocks* of *granulated quartz* and of other *hard sand-stones* are found to succeed those of *granite*, *porphyry*, *gneiss*, and other *primordial stones* which are scattered over the northern part, and which, as I have been informed, extend the whole way along the shore of the *Baltic* into *Russia*. Within a certain zône, however, blocks of granite continue to appear among those of the former kinds, as I have described in the road from *Hanover*, by *Hastenbeck*, towards the *Hartz;* and in travelling through *Flanders* I also saw repeated changes in the nature of the stones with which the road was paved; some appeared to be of *porphyry*, others of *granitelle:* but I could not learn whether they had been extracted from scattered *blocks*, or from some hill.

Sept. 11*th.* From *Brussels* I went on to *Ghent*, intending, from the latter place, to proceed by the canal on the inner side of the *dunes*, which, in sailing along this part of the coast, I had seen to extend the whole way into *Holland.* From *Ghent*, therefore, I sent back the chaise which I had hired at *Cassel* for this journey.

Sept. 12*th.* I set out from *Ghent* for *Bruges,* at eight in the morning, in a large and very commodious boat, which is about eight or nine hours in performing this passage.

264. This canal, like many others, is the widened bed of a small river, which, in the upper part of its course, winds between sandy hills, covered with heath, and extending beyond *Breda* and *Arnheim:* in digging to form the canal, horizontal *strata* of *sand-stone* have in many places been discovered. At half past four, I arrived at *Bruges,* whence I immediately set out for *Ostend,* by another canal, carried also within the *dunes,* and bordered, on the other side, by a very low flat country.

Sept. 13*th.* From *Ostend* I set out in a carriage, at 10 in the morning, for *Dunkirk.* At low water, there is a road along the strand to *Newport;* but I preferred travelling within the *dunes,* in order to observe the soils which are protected by them against the attacks of the sea. As far as *Furnes,* there is a causeway, leaving *Newport* at some distance. The country immediately around *Ostend* is extremely desert, being covered with sand; but farther inland there is a very fertile soil, which is argillaceous, and is covered with *peat.*

265. The *dunes*, or hillocks composed of the *sand* ught up from the strand, when dry, by the sea-inds, extend along almost the whole southern coast f the *North Sea*, this coast being in most parts ordered by shoals, the sand of which is carried to-ards the shore by the waves and the tides; so that ere the openings to the sea, including those at *Ostend*, *Neuport*, *Dunkirk*, and *Calais*, are all pro-duced by small rivers preserving their course across e *dunes*. The case would have been the same ith the *Rhine* in the *dunes* of *Holland*, had not is great river, at some distance from the sea, ided itself into four branches; the branch which, aving the straitest course, retained the name of *hine*, passing through *Holland*, two others, the *eck* and the *Waal*, proceeding westward to join the *euse*, and the fourth, which is the *Issel*, falling the eastward into the *Zuyder-see*.

266. In the vth Vol. of my first Travels, I explained what had happened in *Holland*, with respect to the *Rhine*. When the Romans were in that country, they had a custom-house on the strait branch of the river, which had preserved its course through the *dunes*, and at that time formed there the principal communication between the sea and the land. But the sand was driven by the waves in greater quantities against this point, than against any other on the whole length of the coast, while the winds carried it hence to a greater distance over

the lands; so that the *dunes* acquired here an tonishing breadth and height. Thus the bed of branch of the river was gradually raised by the that fell into it; and the *dunes* at last exten across it, the stream which now retains the nam *Rhine* is a mere *canal*, passing on to *Leyden*, terminating within these *dunes*.

267. To judge by the appearance of the cou between *Ostend* and *Calais*, it is probable that ancient times, peat began to be formed here, as as in *Holland*, whenever the *dunes* had risen to s a height as to prevent the sea from spreading the lands at high water. From *Furnes* to *Dunk* I travelled on the embankment which borders canal, and is composed of the *sand* dug out of this sand was full of *shells*, as fresh and entire those on the strand on the outer side of the *du* a proof that the *peat* had been formed on a consisting of the *sea-sand*, which the waves continued to spread over this space as long as brooks had deposited their sediments in suffici quantities to bind it, and secure it from becom the sport of the winds; a process common at on all coasts, along which, wherever the stra have been composed entirely of pure *sea-sa* *dunes* have at last been raised.

268. The entrance of each of the ports abo mentioned is a passage preserved by a small ri

throu

through the *dunes*; and the means employed for guarding the lands behind, which are of great extent, and in general very fertile, secure, at the same time, not only an easy interior navigation, but a communication from the latter to the sea. The course of each of these small rivers through the *dunes* has been bordered, on both sides, with very strong walls; between which are two sluices: the inner sluice serves to retain the water in the canals at the height of the middle tide, and the surplus of the land-waters runs off during the ebb: the outer one serves, as is the case with all double *sluices*, to carry vessels out to sea, and to bring up into the canals those which arrive thence.

Sept. 14*th*. At seven in the morning I set out from *Dunkirk* for *Calais*, taking *Gravelines* in my way. The canal, being at the level of the middle tides, is some feet higher than the lands within: it is cut in the foot of the dunes, and a causeway runs along its side. It has probably happened here, as in *Holland*, that the soil has subsided since it has been drained by the canals; but not nearly in so great a degree, because this soil consists of *sand*, mixed with but a little of the mud of land-waters; whereas that of a part of *Holland*, having been chiefly formed by the sediments of the *Rhine* and of the *Meuse*, covered with a great thickness of peat, when enclosed with dykes, and thus prevented from receiving any fresh sediments, sank so much, that,

throughout a very extensive tract, it is no less th
15 feet below the level of the ebb-tides.

269. From *Dunkirk* to *Calais* I travelled almo
the whole way over the *dunes*, which are very wide
but not high. There was a strong westerly wind
and this occasioned the upper part of the *dunes* to
bear the same appearance that I have seen in the
passages of the *Alps* during winter, when the snow
on those mountains is pulverized by frost: this snow
is then caught up by violent winds, and when thic
clouds of it are seen from the foot of the mountai
travellers do not venture to ascend; because, at th
same time that it effaces all the beaten paths, i
forms a kind of mist, through which the stake
planted to mark them, at certain distances, cannot
be discerned. Such was now the appearance of the *dunes*, for clouds of *sand* were flying over them; and it was easy to judge that, but for the *carex* and *arundo*, the seeds of which, transported also by the wind, spring up on this *sand* as soon as it is moistened with rain, not only binding it with their roots, but detaining with their stalks such particles as are driven into their interstices, no *dunes* would have been raised here, and the country, to the distance of two or three leagues, would be wholly covered with the *sand*, in which the winds would still continue to make deep furrows.

Sept. 15*th*. I spent this day at *Calais*, in order to observe the neighbouring country. The *dunes* ontinue as far as the *chalk* hills, which, at a league's stance from the town, begin to border the sea. I followed for some way the high road leading to *Boulogne*, on a low soil behind the *chalk* hills, and I was struck with the quantity of *siliceous gravel* of which this soil is composed; the canal passing along here is in some places above 20 feet below the surface, and in the whole depth of its sides I saw only this gravel, with scarcely any mixture of sand. Yet the outer strand consists entirely of *sand*, which the winds raise up in *dunes;* and nothing is seen at he foot of the *chalk* cliffs, but *flints* of a totally ifferent species. The same *siliceous gravel* is found n many of the interior parts of the continents, where there is no *chalk*; I have seen it in *chalk* in some parts of *Champagne*, and in the cape of the *Needles* in the *Isle of Wight*; but it is not of the kind which is found either in the *chalk* hills of *Calais*, or in those of *Dover* on the opposite side of the Straits.

Sept. 16*th*. I embarked at *Calais* for *Dover;* thus terminating a journey that had occupied me two months, through countries very dissimilar in their nature, most of them so much frequented, that the geological facts which I have here described may be easily verified; and it may, I think, be judged, that, if these are exact, they confirm my system of Geology in all its parts. With regard, however, to an object so vast, and so long involved in error by superficial observers, it is impossible to extend observations into too many different countries, since thus not only will more people have i in their power to verify them, but, the same fundamental phenomena being attended with a greate variety of circumstances, it will be the more easy t judge whether they have been generalized with exactness. It was by these considerations that I wa determined in the plan of the following Travels.

TRAVELS *in the* PENINSULA *of* BREMEN, *at different Times, and in different Directions.*

270. I HAVE frequently remarked, and it must have evidently appeared in the preceding Travels, that the *masses of stones*, which certainly belonged originally to *strata* of known species, but are now scattered over the surface in countries where these *strata* are not seen, form one of the most important of geological *monuments*; since they offer a rigorous criterion of the different systems concerning the *revolutions* which have happened on our globe, and which are indicated to us by the *fractured* and *disordered* state of the *strata* composing the mass of the *continents*; so far as it is within the reach of our observation. For every system which does not, in a precise manner, explain all the various circumstances of this great phenomenon, so intimately connected with the present state of our *mineral strata*, is deficient in the most essential character of truth.

271. In most of the systems which ascribe an incalculable *antiquity* to our *continents*, whatever be the cause assigned for the retreat of the *sea*, these *masses of stone* are supposed to have *migrated* on their

surface from *eminences* composed of stones of the sa
genera. The first general fact which I opposed
this supposition was, that these *masses* are found
spots separated from all stony *eminences* by ma
deep *vallies*. Now in order to avoid the conclusi
immediately resulting from this fact, recourse wa
had to the hypothesis that the *vallies* had been ex
cavated by running waters *subsequently* to the *mi*
gration of these *masses*. To my next objection
that *vallies* are no where observed to have becom
deeper, it has been replied that this effect is *to*
slowly produced, to suffer successive generations
men to transmit to each other the account of an
steps observed by them in its progress. On a sub
ject less important, it might be sufficient to remar
that with answers like this, which admit no crit
rion, the most direct objections might be evade
But here the *History* of the *human race* is deepl
involved; and I have therefore neglected nothin
for the purpose of collecting together the *fac*
which refute a hypothesis thus completely *gratuitou*
with the view of at last eradicating so dangerou
an error from the minds into which it has been i
sinuated.

272. I have already opposed to it, with muc
detail, two great classes of *facts*; one with respe
to these *masses* themselves, which, if, at howev
remote a period, they had proceeded from any em
nence, it should be possible to trace back thithe
beyond the vallies supposed to have been subs
quent

quently excavated on their road; and which, in that case, we should find scattered in greater abundance, proportionally as we approached that pretended source. This is even what has been assumed by Mr. Playfair as the real *fact*. Now I have described accumulations of *blocks* and *gravel* in many spots very distant from all mountains, and encompassed by spaces in which few or none are found. The genera and species of these scattered masses are also seen to change from place to place; and among them there are many of kinds unknown in any mountain within a great distance all around. The other class of facts which I have opposed to this hypothesis consists of evident proofs that the *vallies* are not assignable to *running waters*, but that they existed on our *continents* before the *sea* retreated into its present bed; having been produced by the catastrophes which were undergone by the *strata* while still beneath its waters.

273. But there is besides another class of facts to which this hypothesis cannot be applied; I allude to the *islands*, whereon are found quantities of *blocks* of various species not belonging to their own *stony strata*: it will not surely be supposed that these slands were not surrounded by the *sea* until after he *blocks* had arrived on them from the *continent*. Now in my *Travels on some parts of the coasts of the Baltic and the North Sea*, I have first described, in the *Baltic*, the *Danish Islands*, with those of the

Poel and of *Rugen*, and afterwards, in the *North Sea*, some other *islands* on the coast of *Sleswigh*, all of which are covered with *granitic blocks* in great abundance.

274. Lastly, such *peninsulas* as contain no *mountains* to which the *blocks* now scattered over them can have belonged, are, in this respect, in the same case with the *islands;* and in the above Travels I have related, with many details, my observations in the long *peninsula* of *Holstein* and *Sleswigh*, separating the *Baltic* from the *North Sea*. I have mentioned there likewise that of the country of *Bremen*, situated between two long gulphs, one of which, on the east, receives the *Elbe*, and into the other, on the west, the *Weser* discharges itself. I considered the latter *peninsula*, in particular, as very important to be observed under this point of view; not only because, it being more frequented by travellers than the former, my observations in it might more easily be verified, but likewise on account of its still greater distance from any *mountain*. Besides, this *peninsula* lies in the road to several countries of *Germany* in which I have had occasion to travel. I have therefore crossed it in different directions, either purposely, or in my way to other places; and as, in passing through it, the *blocks scattered* in various situations have always formed my principal object, I have thought it best to collect together all these journeys under the same title.

Aug. 9*th*, 1797. I arrived from *Yarmouth* at *Cuxhaven*, situated at the extremity of the *peninsula* of which I am now speaking. The port is an artificial canal at the mouth of a very small stream; it is bordered with dikes, for the purpose of securing against the high tides a great tract of meadows, which extends westward, and is composed of the *sea-sand* driven in by the waves and the tides: no *dunes* having been formed on the side next the sea, these meadows, drained by canals, are there guarded by a dike, which, as its nature engaged my attention, I followed for a considerable way. I found assembled in it vast quantities of *blocks* of *primordial stones*, some of them very beautiful, and not seen in any of the *strata* of the nearest chain of mountains, namely, the *Hartz*; in my endeavours to learn whence they had been brought, I had he good fortune to make acquaintance with M. Volsmann, Director of the works of the port nd of the dikes, who was so obliging as to give me all the information which I shall now proceed to detail.

275. It was not till the year 1733, that this coast had been brought to such a state by natural causes, namely, the actions of the sea and of the land-waters, as to suggest the design of making advantage of their operations. The first thing which was then done was to secure the entrance of the port, and the dikes that border the canal, by two moles composed of large masses of stone. Dikes against the

sea had been raised some time before, in front of a great extent of *new lands* on the west of the port, which it was intended to convert into good meadows: but those who conducted this work, not understanding the science of *dikes*, had made them too near the coast, with inflexions following those of the lands: the consequence was that, during violent tempests from the open sea, these dikes were broken down, especially in the parts where the waves rushed with the greatest force into their recesses. For some time, it was attempted to break the waves by fascines; but this expedient proved very expensive; for the fascines soon decayed, in consequence of alternations of moisture and drought, and the waves then, attacking them, suddenly demolished the whole work. The plan of employing *blocks* for this purpose was suggested by the quantities which were scattered over all the neighbouring countries; and in 1776, its execution was commenced. These *blocks* being known to abound greatly on the soils of *Mecklenburg* and *Holstein*, they were first brought from thence; but when all those near the coast had been removed, the expense increased proportionally to the distance at which it became necessary to seek for more; and all the *blocks* found at the extremity of the peninsula near *Cuxhaven* itself, had been exhausted, in earlier times, by the similar works carried on in *Holland*. At last, about the year 1785, a space within this peninsula was remarked as being entirely covered with them, whence, though the distance was considerable, they might be brought at little ex-

pense,

ense, by means of the small river *Lühe*, which
asses this way to join the *Elbe:* this space is in the
eighbourhood of *Hornburg*, an inland town be-
veen the ports of *Stade* and *Harborg*. M. Wols-
iann informed me that, since that time, about 600
sts of *blocks* had been brought from thence every
ear to this extremity of the peninsula, the *last* con-
sting of 400 quintals; and these had been em-
loyed in constructing a *dike*, which was seven or
ght feet high, and of sufficient breadth to resist
e greatest impetuosity of the waves, and which,
ginning from the dike of *Cuxhaven*, already ex-
ded three-leagues to the westward of that town.
may therefore be judged what a prodigious quan-
y of blocks had been brought hither from one par-
ular district of this *peninsula*.

276. I walked along the dike a considerable way,
d was in continual astonishment at the variety of
ese stones, and the beauty of many of them:
eat numbers of the *blocks*, having been too large
carriage, had been split with gunpowder, which
l even rendered it more easy to arrange them
ly in the wall, where the sides freshly broken
eared in front; among them were several of a
y *granite*, like that which composes the granitic
inences of the *Hartz* already mentioned, as well
the chains of the *Giant's mountains* in *Silesia*,
l of those in the country of *Bayreuth*, which
shall hereafter describe; but were any one
posed to fancy that those *mountains*, notwith-
standing

standing their remoteness, and the intervening *gulph* of the *Elbe*, had been the sources of the masses scattered on the *peninsula*, his imagination might still be stopped by the different natures of the other masses, among which I saw a great variety of fine *granites* containing *red feld spar*, of *porphyries*, of *gneiss*, and other *quartzeous stones;* none of these being in the mountains mentioned above as the only eminences to which it could be possible to refer. I now formed the design to take some future opportunity of going to observe the country round *Hornburg*, and in the sequel I shall describe it; but it will previously be seen that there was no other reason for bringing the *blocks* from that particular spot, than merely the convenience of transporting them down the *Lühe* to the *Elbe;* for there are many other parts of the *peninsula* which could have furnished them in equal abundance.

277. I set out the same day for *Neuenwalde*, at the distance of about three * German miles. The *new soils*, which have been formed by the *sea-sand* and the sediments of the *Elbe* around *Cuxhaven*, *Ritzenbuttle*, and the eminence whereon the latter stands, are very fertile, and for the most part covered with fine meadows; they are more than a league in breadth, and border the *original coast*,

---

* It will be unnecessary to repeat, in these Travels, that the distances in *Germany* are always reckoned in German miles, each of which is equal to about five English miles, or two French leagues.

which rises in *sandy* hills. In the 1st Vol. of my Travels lately published, I mentioned that the name of *geest* is given to these sandy soils, in order to distinguish them from the *marshes*, or *new lands* added to the coasts, which, before they were enclosed with dikes and drained by canals, were merely *morasses*. This *sand* is of the kind common to *heaths;* I again found on its surface those particles of *white quartz*, which, as I remarked in the preceding journey, appear to belong to it; in its own nature, it is very barren; but it may be rendered fertile by manure and tillage: this appears, within a certain breadth, in the *geest* which borders the *meadows*, because cattle are kept in the neighbouring villages; but beyond this zone, nothing is to be seen but hills covered with *heath:* I travelled two miles without perceiving in the whole horizon any house, or even a hovel, or a single tree; and how easy it is to miss one's way in such a country will appear in one of my subsequent journeys. Such is the state of this whole peninsula, except in the vales where rivulets flow, which are covered with *peat:* I crossed one of these vales before I reached *Neuenwalde;* it was covered with good grass, having been drained by ditches within the last ten years; and as the winds carry *sand* to the borders of the *peat-mosses* between the hills, those parts were here become arable land. It is from points of this kind that cultivation spreads over the neighbouring soils, because of the cattle kept here; the slopes bordering this vale were thus in tillage, and on some parts of them there were already small woods.

Aug. 10*th.* I set out from *Neuenwalde* for *Bremer-Vöhrde*, by *Bederkesa*, *Heime-Mühlen*, and *Dritgeest*, a distance altogether of four miles and a half. The ground is in tillage around all these villages, for which indeed the situations most favourable to agriculture have been purposely chosen. Now in clearing the lands, *blocks* have been found here in such great abundance, that they are used in all these villages for the foundations of the wooden houses, for the enclosures of orchards and gardens, for pavements, and for the stone posts placed along the houses and the sides of the road; yet many are still lying on the borders of the fields. It was very evident that all these *blocks* had been taken out of the cultivated lands; because the heath was covered with them in as great abundance near the villages, where so many had been used, as in other parts; nor did they all appear at the surface; for in this country, which is so little frequented that no attention is paid to the roads, it is impossible to make any speed in travelling, lest the wheels or axle-tree of the carriage should be broken by striking against the *blocks* buried under the sand, as I had already experienced on the hill near *Osnaburgh.*

278. But I met with a still more remarkable phenomenon of this kind near the village called *Dritgeest,*

geest, (or third *geest*.) This village is situated on the side of a hill sloping down to a branch of an immense *peat-moor*, which extends to a great distance northwards, and bears the name of *Langemeer*, (long *lake*;) whence it appears that, at the time when the German language was introduced into this country, there was here a *lake*, which has been since filled up with *peat*, like some that I have described in *Mecklenburg*: in this *peat-moor*, there are still spaces occupied by water. Across this branch, a very long causeway had been recently formed from *Dritgeest* to the succeeding *geest* or *sandy* hill. These causeways in *peat-moors* are made first with *sand*, passages being left across them for the rills of water; more *sand* is then thrown on, till by its weight, in wet seasons, it has displaced the *peat*, and reached the ground at the bottom; fter which it is covered with stones, to produce firm road.

279. All this had already been done along the auseway from *Dritgeest*. I went down on it, while e horses were feeding, in order to observe it; and esides the stones with which it was in a manner aved, I saw that the whole way, on both sides, were tone-posts, made of very beautiful fragments; and laced very near each other. On my inquiring whence these stones had been brought, an excavaion was shewn to me at a small distance on the slope of the hill: I went up to it; and although so great a quantity of *blocks* had been taken out, they were still accumulated there in such prodigious a-

bundance, that they appeared to form the mass of this slope, which was turned towards the large vale, and consequently towards the point of a great *subsidence* of the *strata*. Hence may be formed some idea of the *quantities* of these *blocks;* but as I wished to observe more particularly the *variety* of their *species* which I had remarked in the stone-posts at the beginning of the causeway, I went back to tell the postillion that I meant to walk on, and that he should meet me at its farther extremity. I then followed the line of these *stone-posts,* which presented towards me their sides freshly broken; and I do not believe that a finer collection of *primordial stones* can any where be seen. I observed there some *granites* not excelled by any of the Egyptian kinds either in beauty of colour, in hardness, or in the brilliancy of their crystals, which were not only of different tints, but of different sizes; there were also several species of *gneiss,* very hard *porphyries,* masses of a *porphyric* substance but without *crystals, jaspers,* and other genera of stones; and in some of these masses I could plainly distinguish *strata* of different natures.

280. Here then are *stones,* not belonging to any of the mountains within a great distance all around, and appearing as if artificially accumulated on a hill in a *peninsula* intersected with *vales,* which, being covered with *peat,* have certainly not been *excavated* by the brooks now flowing in them. Hence it is impossible to suppose that these *blocks* can have been detained here by any cause, in the course of

their *migration* over the continent from a very remote distance, and formed into this vast heap; they must have been expelled from within, during the catastrophes of the *strata*, in the very spot where they are at present found. Now this great conclusion, which is of such general importance in Geology, and has already been supported by so many facts in my preceding Travels, will be confirmed in the sequel by a variety of other phenomena. In the neighbourhood of this spot, I saw *flints*, mixed with other gravel, beginning to appear on the surface of the sand.

281. Within a certain distance, I continued to see many *blocks* along the road; but, so long as they are observed only on heaths, where they are covered with *lichens*, it is impossible to distinguish their nature, which does not appear, except when they are freshly broken; and in this state I again remarked many of great beauty, among the *stone-posts* bordering other causeways across branches of *peat-moors*. But the finest collection which I saw was in the wall of the garden belonging to the Amt-house at *Bremer Vohrde*, where I did not now make any stay, because neither the Amtmann MAYER, who had so hospitably received me in my travels through this country in 1778, nor M. FINDORFF, my intelligent guide in the great *peat-moors* of the neighbourhood, were any longer at this place. I therefore presently quitted it for *Closter-Seven*, at the distance of three miles. In parts remote from habitations, the heath rose to such a height as

almost entirely to conceal the *blocks;* but cultivation had extended itself around two principal centres, *Selfigen* and *Closter-Seven*, as well as around some smaller clusters of houses: and the surface of the heath having been here taken off, for the purpose of spreading the turf over the cultivated lands, I saw, on the soil thus laid open, abundance of blocks as far as the borders of the fields; so that those placed along the side of these lands next to the road, and in the villages, have all been taken out of the ground when cleared for tillage.

282. Between *Selfigen* and *Closter-Seven*, a bridge had been begun over a canal cut for the purpose of opening a communication between some large *peat-moors*, and thus draining them all together by leading their waters in a deeper channel towards two small rivers, the *Oste*, which discharges itself directly into the *North Sea*, and the *Swinge*, which joins the *Elbe* near *Stade*. For this work, fragments of *blocks* had been brought hither in vast abundance; and among these I saw the same varieties of fine *primordial stones:* I remarked especially a *granite* similar to that described on the summit of *Mont Blanc* by M. de Saussure, whom the position of its *strata* induced to acquiesce in the conjecture of M. DE DOLOMIEU, that the *granite* first formed was that which contains the smallest quantity of *mica*. Among the masses collected for the bridge, there were several species of *granite* containing very little *mica;* one of these species, in particular, was very remarkable; its crystals of *feldspar*, as well as those

of *quartz*, were perfectly *white*, and were thinly interspersed with specks of *mica* nearly equidistant from each other. On these heaths, I frequently observed masses distinguishable from a distance by their whiteness, and I always stopped the carriage, in order to go to examine them: they consisted of the same *white granite* with very little *mica*, which, though much indurated, (as I tried, for I constantly carried with me a large hammer,) was covered with its own *crystals*, detached from the mass by decomposition; by this circumstance, the *lichens* were prevented from growing on it, and its colour was consequently not concealed. Inquiring of the men who were at work on the bridge whence the masses collected for it had been brought, I was told that they came from no great distance; and that, in clearing away the sand around those *blocks* which appeared at the surface, in order to split them with gunpowder, others were generally found buried either under them or near them.

283. Though these hills are almost every where covered with heath, there are on them a few spaces where the *sand* is so fine and so pure, that the winds plough it up, and scatter it over the heath around. It was for this reason, that when, in my first travels, I went to observe the thickness of the *blackish earth* produced on the *heath-sand* by the remains of decayed vegetables, in places which were so remote from all habitations as to be still in a state of nature, I commonly found some of this *white sand* mingled with the *blackish powder*. Now

in my present journey, wherever the winds, following some particular track, had furrowed the sand to any considerable depth, I saw, uncovered, *blocks* among gravel and masses of intermediate sizes, consisting of the same kinds of stones which were used in the pavements of the neighbouring villages and towns. I saw likewise on the heath some artificial mounts, composed of one large block in the centre, with others ranged around it all covered with lichens; these are *tumuli* of the ancient *Germans;* and I shall soon have occasion to describe, on these heaths, a more considerable monument of the same nations.

284. In the course of this day's journey from *Bremer-Vohrde* to *Rotenburg*, which is three miles beyond *Closter-Seven*, I came to many cultivated spots, and I saw that agriculture was continuing to extend itself. All the vales within this space being covered with peat, and every where drained, they were already overspread with good grass, and afforded pasturage. The small river *Au* passes by *Closter-Seven*, and flows through some of these vales of which I shall speak more particularly in another journey. There were several young woods in a space evidently appearing to have been occupied, in more ancient times, by a forest; for many old stumps of trees were scattered among the heath. In my first Travels, I mentioned some tracts which retain the name of forests, though a few straggling decayed trees are now the only vestiges of their

former state, and no new plantations can be made to thrive there; whence it is manifest that, since the birth of the continent, the soil must have undergone a change.

Aug. 11*th.* I set out early from *Rotenburg*, that I might reach *Hanover* the same day. As far as *Kettenborg*, I remarked every where the same circumstance with respect to the situation of the *blocks;* namely, that some spaces where they were very thinly scattered were succeeded by others in which they were accumulated in prodigious quantities; the latter was the case chiefly in tunnel-shaped concavities, such as I described in my last journey, where I particularly spoke of some, near *Osnaburgh*, entirely surrounded by eminences, except at the point which affords entrance or issue. Between *Kettenborg* and *Walsrode*, cultivation had already made considerable progress, and appeared to be checked in those places only where the *blocks* lay in too great abundance.

285. From *Walsrode* I set out for *Hadenstorf*, at the distance of two miles. *Walsrode* stands in a plain, through which passes the small river *Böme*, in its way to join the *Aller* on the S. W. After crossing the former stream, I ascended a small hill by a deep cut, in the sides of which I saw that the superficial *gravel*, composed of *primordial stones* and of *flints*, extended to no great depth; and that below it were *strata* of pure *sand*, distinguishable from each other

by the difference of their colours. The upper part of this hill was a *heath* of vast extent, which having been pared and grazed, *blocks* might be descried on it from a great distance: for some way, I observed a few here and there, and among them, one of that *white granite*, on which no lichens grow, because its surface suffers decomposition; but, as I proceeded, I found the quantity of the *blocks* diminish, till at last they totally disappeared, as did likewise the gravel; so that, even in the furrows made by the wind in the loose sand, not a stone of any kind was to be seen. Were it not for the *carex arenaria*, which is continually springing up on this *sand*, and of which the stalks detain the particles carried about by the winds, it would not be possible to cultivate such soils as these; and it indeed now requires great patience in the inhabitants, who are satisfied with scanty crops of rye and of buckweed, not being accustomed in this country to see any thing better. I noticed this particularly at * Hademühlen*, a village standing in a small wood of old trees, with some fields of rye near it; the crops here were extremely thin; and the *carex arenaria*, by which alone the grain was protected, maintained its right of possession even among the ears.

286. The next stage was to *Mellendorf*, two miles and a half beyond *Hadenstorf*. From the latter place I descended towards the small river *Aller*, and having passed it by a ford, I entered a flat plain, which it took me about four hours to cross. The *sand* here continues the same; but the plain being

surrounded with hills whence rivulets descend, and the snow lying on it in winter, the heath is mingled with a greater variety of other plants, and a greater quantity of *vegetable earth* is formed upon the sand; so that this space was already partly cultivated. I did not observe here any stones.

287. I was now, properly speaking, out of the *peninsula;* that is to say, I had advanced on the *continent* beyond the point to which the tide rises in the *Elbe,* and above which the river, having arrived from distant *granitic mountains* to the east, pursues its course alone; yet I saw no more *blocks* of *granite.* As I ascended towards *Mellendorf,* I at first perceived nothing in the *sand* but *flinty gravel,* and particles of *white quartz;* but afterwards, as long as I had sufficient light for observation, all the *stones* and *blocks* which I saw on the hill were of *granulated quartz.* Thus vanishes all probability that the *blocks* of *granite* found in such vast abundance over the whole *peninsula* have proceeded from any *mountains,* even admitting the supposition that the *Elbe* may have excavated its valley at a later period; which supposition however, though it may be entertained with respect to rivers viewed only in maps, must necessarily be abandoned when the real course of those streams is observed; as I shall have occasion to shew in describing the *Elbe* itself.

287. *a.* In the evening I arrived at *Hanover*, where I had much pleasure in again seeing some very dear friends: the excellent Dr. ZIMMERMANN indeed was now no more; but I found here his virtuous and amiable widow, for whom I have always retained a very sincere friendship. The worthy M. VON PAPE, Director of the post-houses in this country, was still alive; and as he knew what were the principal objects of my observations, he proposed to me two excursions, on which we soon afterwards set out, and of which I shall in future give the details; but, as I announced at the beginning of this article, I shall here confine myself to accounts of my travels in the *peninsula* of *Bremen.*

Oct. 4*th*, 1797. I set out from *Hanover*, in company with a lady who was going to *England.*

288. As we began our journey in the morning, we saw by day light that part of the road along which, in my way to *Hanover*, I had travelled late in the evening. I have just said that, from the borders of the *Aller* to *Mellendorf*, I had seen no ,*blocks* and that, after passing the latter place, I had observed nothing, as long as the light had lasted, but masses of *granulated quartz*. But now, at a little distance from *Hanover*, I again saw *blocks*

of *granite*, especially along the village of *Langenhagen*, where they lay in great abundance.

289. After we had passed *Mellendorf*, our postillion, who had never travelled this stage before, lost his way; and instead of driving us to *Essel*, in the road to *Walsrode*, he went towards *Wickenburg*, in that to *Zell*: as these heaths are crossed by roads in all directions, we had travelled three leagues before he discovered his mistake; and we then learnt that we were as far from *Essel* as from *Mellendorf*. I was vexed at this incident on account of my companion, since it now must be night before we could reach *Walsrode*; but for myself, I was not displeased at having thus an opportunity of travelling three leagues along the zone without *blocks*, already mentioned as lying in the interval between the end of the *peninsula* of *Bremen*, which is covered with *blocks* of *granite*, and the neighbourhood of *Hanover*, where they again appear. I saw nothing but small *flinty gravel* in all the part of this zone over which we now passed, and which consisted wholly of sand. We did not arrive at *Walsrode* until half past ten at night.

Oct. 5th. Travelling this day from *Walsrode* to *Closter-Seven* through *Rotenburg*, by the road before described, I again remarked those spaces where the *blocks* of *granite* are accumulated in such astonishing quantities, with the intervals in which very few are to be seen.

Oct. 6th. This day we proceeded by *Selfingen* and *Bremer-Vohrde* to *Bederkesa*, a part of my route which I have also described; but there being no high roads over these heaths, the postilions follow any that present themselves in the proper direction; we happened, now, therefore, to take a different road, which gave me an opportunity of observing two new phenomena. After we had passed *Selfingen*, we came to another of the large excavations made for the purpose of taking out sand and stones, which were carried from this spot to form a new causeway across a branch of a peat moor; on one of the sides of the cavity, I saw, still imbedded in the sand, two immense *blocks* of *granite*, resting on a third; and the latter was split into two pieces, which lay at some distance from each other. This effect, as it could not have been produced by the weight of the superincumbent *blocks*, must have resulted from the *percussion* occasioned by their fall; so that this is, in fact, the same phenomenon which I described § 137, on the mountains of *Neufchatel.*

290. The other phenomenon was a deep furrow, made in the sand at first by the wind, but since followed by the rain-waters, which having considerably deepened it, all the *gravel*, originally contained in the *sand* that had been washed away now lay on its bottom; and here I saw as fine a collection of *primordial stones* of various species, as can be found on those parts of the borders of the *Lake of Geneva*, of which M. de Saussure has given so in-

teresting a description. Near that lake, these stones might be supposed to have proceeded from the *Alps;* although I have shewn that the whole soil of the country, on the heights as well as the plains, is there full of the same *gravel,* with *blocks* of a similar nature. But on the *peninsula* of which I am now speaking no such illusion can take place; the *gravel* cannot have been transported hither from any quarter, since the continent has existed: and throughout this whole tract it is found in all the superficial *sand* which lies on regular strata of other sand wherein no gravel is contained.

291. In this country, some of the sandy strata have a yellowish tinge, imparted to them by a *martial earth,* which separates from the *sand* in washing, and leaves it pure, with a shining grain. This *earth* has a singular property, very inconvenient in agriculture: in some places, especially in the country of *Luneburg,* at a small depth beneath the turf, it binds the sand in very hard *concretions,* which are known by the name of *Ort-grund;* they are only a few inches in thickness, but they effectually prevent the growth of trees and of shrubs: it has been repeatedly tried to break this crust, and to make plantations here; the trees, being planted in separate pits, appear at first to flourish; but after a certain time they decay, because the soil again concretes around their roots, always at the same depth beneath the grass. I have had an opportunity of knowing that the same phenomenon occurs likewise in *Botany bay,* having seen

tubs of plants arrive at *Kew Garden* from that part of the globe. These tubs were filled with a sand similar to that of our heaths; and when it was emptied out into the holes which had been made to receive the plants, in order that they might have around them, in the garden, their native soil, a bed of concretions absolutely similar to the *Ort-grund* was found at the bottom of the tubs, where it had been placed to cover the holes, and prevent the sand from running out when the plants should be watered in the course of the voyage.

Oct. 7th. At 7 o'clock in the morning, we set out from *Bederkesa* for *Ritzenbuttle*, which is near *Cuxhaven*. The whole of this day's journey was to be only three miles and a half.

292. The postillion, according to the usual custom, stopped half way, at *Neuenwalde*, to feed his horses; and as this always takes up at least half an hour, I determined to walk on, till the carriage should overtake me. After I had proceeded a certain way, I came to a point where the road was divided into two branches, passing on the opposite sides of a piece of higher ground in tillage; seeing some men at work there, I asked them which of these was the way to *Ritzenbuttle;* they shewed me that on the right, and I accordingly followed it. Afterwards, however, the road again branched off several times, in different directions, which very much perplexed me; and I walked on for more than

an hour, without meeting any body on this heath, where I had no other means of guessing the right road than by examining, at every fork, which branch appeared to have been the most frequented. At last, a countryman crossed before me; and on inquiring of him whether I was in the road from *Neuenwalde* to *Ritzenbuttle*, I learnt, to my great regret, that I was more than half a league too far to the eastward: unluckily, the man was going in a direction contrary to mine; but he shewed me, at some distance, a hill, over the foot of which, he said, I must pass: my curiosity, however, was so much excited by an object on the summit of this hill, that I first ascended thither to view it, not supposing that I should find any difficulty in descending from that point in the proper direction.

293. On reaching this object, I perceived it to be a place of worship of the ancient inhabitants of the country, similar to several others which I had elsewhere seen. Two large upright *blocks* of very fine *granite* with red feldspar, stood at about the distance of four or five feet from each other, supporting, horizontally, a third of greyish granite, about eight feet in length, and four in thickness. *Blocks* thus arranged are believed to have been the altars of the ancient *Germans;* for around them have been found various instruments used in sacrifices, such as axes and knives, very neatly made of *flint*. A knife found near one of these altars was given to me in my first journey, when I visited the

spot; it is pointed, and has as good an edge as if it had been ground; yet it evidently appears to have been only split off, like a gun-flint. Around these altars there are always *tumuli*, and I saw a great many near this of which I am now speaking; they had been opened, and urns of terra-cotta, containing ashes and remains of bones, had been taken out of them. The shepherds had converted this altar into a hovel, having closed it up on one side with a turf wall, and covered the bottom with straw.

294. After having examined these objects, I began to look around me. Nothing could be more perfectly desert than the general appearance of the country; on all sides, as far as the horizon, which was not bounded by any near object, hills rose behind hills, all cloathed with the same uniform covering of heath; and not only was there, throughout the whole of this vast space, no trace of any human habitation, but not a single tree was to be seen here, nor were there even within my view any flocks of the *Heide-Schnucken*, or sheep of the breed of those kept by the ancient shepherds of the country: these sheep have a sprightly look, and are very nimble; they live through the winter on these hills, and scratch up the snow with their feet, in order to find the young shoots of the heath, on which they feed; their wool is coarse, and being either brown or black, it does not require to be dyed when it is made into cloth for the country people.

295. I spent some time in contemplating this dreary prospect, which was however new to me, and led to many interesting reflexions; but I fell afterwards into a great perplexity. When I would have proceeded on my journey, I found it impossible to distinguish on which side of this hill I had ascended to its summit; for the sky was cloudy, and the horizon presented no object that could lead me to judge what way I was to turn my course; nor was it of any use to look for a road across the lower part of the heath, which was of great extent; for instead of one road, I saw it intersected with innumerable tracks in every direction. I then determined to walk on towards an eminence at some distance, of greater height than this whereon the altar stood, and likewise more lofty than any of the others around it, in the hope that from its summit I might gain sight of some house. Unluckily it now began to rain; and the heath, through which there was no path towards the eminence that I had in view, was soon completely wet.

296. When I had ascended this second hill, I did really descry, at a considerable distance, another on which was a wind-mill, where I was sure that I should find somebody, because its sails were in motion; I therefore immediately hastened towards it, but still through the wet heath, as I could not discover any path to the mill, till I came to the bottom of the hill on which it stood. The miller himself being within, I inquired of him where

lay the road from *Neuenwalde* to *Ritzenbuttle*; and I learnt that after having been in the morning a league too far to the eastward of it, I was now too leagues too far to the westward. From the mill I saw a village at no great distance, which the miller informed me was called *Middlum*, and in the intermediate space, I perceived a peasant ploughing: having descended the hill, I went up to this man, and told him my situation, requesting that he would take off the horses from his plough, and carry me to *Ritzenbuttle* in a cart, I cared not of what kind. The peasant, seeing that I had really no other means of reaching that place, asked me to wait only till he had given some barley to his horses, because the road was extremely heavy, being made entirely in the sand; and while they should be feeding, he invited me to eat something myself. I gladly accompanied him to his house, where his wife immediately made a kind of paste of the flour of rye and buckwheat, which she cut into small pieces, and fried with onions; I certainly never dined with a better appetite. The horses were then put to the cart; but the rain having come on with increased violence, these good people wrapped me up from head to foot in the blanket of their bed; and the peasant covering himself in the same manner, we set out, and arrived at *Ritzenbuttle* just as it grew dark. In the mean time, the lady whom I had left at *Neuenwalde*, having neither overtaken me on the road, nor found me at *Ritzenbuttle*, had grown very uneasy; she would have sent immediately along the diffe-

rent roads in search of me; but she was told
, as I was a stranger, I might easily have lost
elf on the heath, where however I should cer-
ly meet with somebody who would shew me the
. But when the evening came on, and still I
not arrive, she dispatched several men to en-
vour to obtain some tidings of me; by which
ns the news of my being lost were spread so
dly, that, as I entered the town, I heard re-
ted from mouth to mouth, "he is come! he is
e!" This report, being carried to the inn,
hed my fellow traveller, before I made my ap-
rance in my singular equipage, which changed
her anxiety into mirth, as soon as she found that
d met with no worse misadventure than being
through, and that I did not regret having lost
way, since I had thus gained more knowledge
he country than I could have acquired in follow-
the usual road.

97. My third journey in this *peninsula*, which
in *March*, 1798, afforded me an opportunity
bserving along its coast a very interesting phe-
nion relative to the *ice* of the *Elbe;* but I now
sed the country from *Hamburg*, and shall
efore first describe the neighbourhood of that
l.

298. The hills are here at a great distance from the *Elbe*, the soil being low to a great extent; this soil, which encompasses *Hamburg*, is in general very fertile, but especially within a wide zone of alluvial lands, enclosed with dikes, along the course of the *Elbe*. In the spot where the town stands, there was originally a creek formed by the lower part of a vale, which follows a branch of a hill descending to the river side; and into this creek the small river *Alster* discharged itself. The tides rising at this point to a considerable height, and the gulph of the *Elbe* being of great breadth, the situation was extremely favourable for a town possessing an extensive maritime commerce; and it has been also much improved by art. The town having been placed within this ancient creek, the first object was to secure the lower part of it against the high tides and the inundations of the *Elbe*, by a dike which forms a broad quay, and in front of which a great many vessels may be moored, and remain sheltered from the winds while laden and unladen. By a high and very strong wall, the water of the *Alster* has been raised in its vale, where it has spread and formed a large pool, which affords a constant supply, in all seasons, to the mills belonging to the town. The surface of this pool is of such great extent, that, in times of drought, the above purpose is answered by only lowering gradually the point of its discharge; and when it is too full, the superabundant water is carried off, at low water, by a canal with a sluice.

299. Lower down on the same bank of the *Elbe* is *Blanckennes*, whither I went, in order to cross this river towards the *Alte-Landt;* a rich and very extensive alluvial soil on the left bank, which is six leagues in continuous length, its average breadth being about one league: it was along this coast that I had purposed to observe a phenomenon of *ice*, frequently seen on a small scale in ponds, and on the sides of lakes, where it had often struck me as conveying a very clear idea of the manner in which the catastrophes of our *strata* were effected by the subsidence, towards the interior part of the globe, of the first disunited elements whereon they had been formed. The shoals on the border of this part of the gulph of the *Elbe* led me to expect that, as the winter had been long and very severe, I might here find a grander scene than I had elsewhere had occasion to observe.

300. In the way from *Hamburg* to *Blanckennes*, I stopped at *Flodtbeck*, the seat of a gentleman who had rendered himself highly respectable by the philanthropic zeal which had led him to study, in various countries, the settlements established for the poor; this object had, in particular, induced him to visit *England*, where I had had the honour of becoming acquainted with him. This was Baron VON VOGHT, who now enjoyed the satifaction of seeing carried into effect at *Hamburg*, his native place, the plan, which these observations had suggested to him for abolishing mendicity. On returning from his travels,

vels, he had communicated his plan to the senate of that city; its object was to oblige those beggars who, though they led an idle life, were able to contribute a little towards their own maintenance, to exert for this purpose their talents and capacity, however small; in order that the product of the public charities might be reserved as much as possible, for those who were incapable of providing in any degree for their own subsistence. This plan had been reduced into a code of laws, which were now in force; and mendicity was thus absolutely banished from the territory of *Hamburg*. At this gentleman's house, I had the pleasure of meeting M. SCHMEISSER, a very ingenious German chemist, with whom I had also been acquainted in *England:* the Baron had brought him from that country, and had provided for him, on his own estate, a chemical laboratory, with many excellent instruments of experimental philosophy; but afterwards, observing the extent of his genius, he had settled him at *Altona*, which is very near, procuring for him there a laboratory on a proper scale for all the great and useful operations of chemistry.

301. On this eastern side of the gulph of the *Elbe*, *blocks* of *granite* and of other *primordial stones* are found in the same abundance as in the peninsula of *Bremen* on the opposite side. Baron Von Voght's house being concealed by a rising ground, he had lately undertaken to form a better approach to it, by causing the earth to be cut away to a great

depth; and I saw here great quantities of *blocks* and smaller stones which had been taken up. From hence I went on to *Blanckennes*, where I embarked with my carriage for *Crantz*, on the opposite bank of the *Elbe*. When I had advanced some way across the river, looking back towards *Blanckennes*, I was struck with the appearance of that village, which is inhabited by the barge-men who frequent the gulph. Three promontories advancing from the hill, and being separated by simple recesses in it, most of the houses are placed in these intervals, in each of which they rise in an amphitheatre, every house having a garden and a little orchard supported by walls of *blocks*. The three promontories having been cut down from top to bottom by the subsidence which has produced the gulph, they are thus become cliffs; the middle one is already reduced into a slope, and covered with grass, being secured against the attacks of the *Elbe* by a high strand, formed in its front by the stones which have fallen from it: the two others are still continuing in some parts to crumble down, because, when the river is much swelled, the highest tides come up to their foot; however below these likewise there is a strand, on which are some houses, situated very conveniently for the watermen, but requiring also to be supported by walls of *blocks*. As I went on towards the middle of the gulph, and thus obtained sight of a greater extent of the same coast, both above and below *Blanckennes*, I saw many similiar promontories, all cut off in cliffs, some of which were already covered with grass, others were still continuing to crumble down: this affords a new example of *progress* in the operations of physical causes on the coasts of rivers, since the period when streams began to flow; and several other effects of the same kind will be seen along the *Elbe* in the sequel of my Travels.

302. *Crantz*, at which place I spent the night, is situated on one of the extremities of the *Alte Landt.* (or Old Land,) so called as being the most ancient of the alluvial lands enclosed, on this coast, with dikes; its history forms one of the *chronological* monuments of that of the *Elbe.* This tract is intersected by three small rivers, which have prolonged their courses through it, and are now bordered by dikes, with a sluice, for the discharge of their waters into the *Elbe*, or its gulph, at low water. One of these rivers is the *Est*, at the mouth of which *Crantz* is situated; there being here a small port, with a double sluice for the purpose of bringing up vessels into the river, or carrying them down into the gulph. I spoke of this land gained from the gulph in my first Travels, where I cited the documents from which it is known that, so late as the eleventh century, all the alluvial soils along the *Elbe* were merely *morasses;* whence they are still called *marsches* in German, though at present they are cultivated. It was in the twelfth century that these lands were granted to a colony of Frisians, who covenanted to enclose them with dikes, and bring them into cultivation. These colonists are now become very rich, but they

have preserved their ancient manners and dresses; the men wear on their coats silver buttons, concave and figured, which are almost as large as eggs, and descend from father to son. But the dress of the women would appear, in any other country, altogether extravagant. It happened that, on the day when I was at *Crantz*, the daughter of the innkeeper there was married, and the bride was presented to me in her wedding cloaths: she was a fresh-coloured young girl, in a corset of scarlet cloth, with gold clasps; and it appeared as if this pretty bust was set upright in a large hen-coop, so widely did the deep folds of her petticoats spread over her hips; seeing how much her figure surprized me, "Ah Sir!" said she, "I dare say you are not used, "in your country, to see women so handsomely "dressed as I am!" Then, taking up the bottoms of her petticoats, which were very long, she shewed me no less than six, all of very thick woollen cloth; the upper petticoats were striped with different colours; the under ones were scarlet, and were very smooth. *De gustibus non disputandum.*

303. From *Crantz*, I set out at a very early hour for *Stade*, which is lower down on the course of the *Elbe*, being at the other extremity of the *Alte Landt;* and it was on this road that I observed the above-mentioned phenomenon of the *ice*. In the course of the winter, which was now nearly at an end, the *ice*, while the river was so much swelled as to cover the *fore-lands*, or soils on the outer side of

the dikes, had become extremely thick; these *forelands* have a very uneven surface, deep gutters being formed in them by the retreating tides, and ridges of sand raised by the waves on their edge. Dry weather having afterwards set in, the ice, as its level gradually sunk, had begun to break on the borders, still, however, continuing to increase irregularly in thickness; and when at last, throughout a very extensive tract of these lands which had been overflowed, the water retired from beneath this crust, because the river itself was reduced to a lower level, the *ice* being thus left resting on so rugged a base, a thousand fractures took place in it in every direction.

304. I first proceeded some way along the borders of the ice, on the outer side of the dike, which I afterwards ascended; and I travelled on it for two hours by the side of this scene of congelation. Some spaces of great extent resembling very exactly the large model of the *Alps*, which had been made at *Lucerne* by General PFIFFER. Here might be observed every form imaginable of *mountainous chains*, rising into *pyramids*, separated by *longitudinal vallies*, and intersected by others in a *transversal* direction. These were the parts where the elevations of the soil beneath the *ice* were divided by the deepest furrows. I observed also, in the intervals of these spaces, phenomena correspondent to those of our *plains*, *hills*, and chains of *mountains* composed, like the *Jura*, of *secondary strata;* these

differences were occasioned, partly by the various periods at which the first stratum of *ice* had subsided, and a second had been formed on it by the water then flowing over it; and partly by the nature of the ground upon which this new *ice*, after the retreat of the water from beneath it, had sunk and been broken. In my opinion, no one who, having attentively examined *mountains* of different classes, shall have an opportunity of studying such a scene as this, will find it possible to doubt that the *causes* and *effects* are in both absolutely analogous; both consisting of *solid strata*, which at first were formed *horizontally*, at a certain level, but which afterwards, in consequence of the *retreat* of their original *base*, underwent *ruptures* and partial *subsidences*, attended with *angular motions* of many of their separated parts.

305. Hence I proceeded to *Stade*, where I had the pleasure of seeing the family of my friend Dr. MARCART, from whom I had received so much assistance in my first visit to this place; but I did not find him here himself. I had not yet observed the S.W. part of the peninsula; and it therefore formed at present one of my objects. With this view, I was first to cross a ridge of hills having on their western side the small river *Oste*, which rises in the *Düvels-moer*, (the vast *peat-ground* described in my first Travels,) and discharges itself into the sea at the extremity of the peninsula. Ascending, from *Stade*, these hills of *geest*, I found

them uncultivated and overspread with heath, the parts lower than the rest of the soil having a superficial covering of peat: throughout this whole space, there are great quantities of *blocks*. From the top of the hill I had a view of the very wide vale of the *Oste*, in which the tides rise as high as *Bremer-Vohrde*. The horizontal soil of this vale has been fertilized by the the sediments of the tides, partly consisting, to a great extent on all these coasts, of the mud of the *Elbe*, which, like that of the *Nile*, carries fertility wherever it arrives. In the *subsidence* of the *strata* whereby this vale was produced, some parts, as is the case in almost all vales and vallies, were left higher than the rest; and these now form ridges of geest, which rise above the level of the sediments, and exhibit the same *gravel*, and even *blocks*, as are seen on the hills. Some of these islands, as they may almost be called, are still heaths, with patches of superficial peat; but I saw others which had been brought into cultivation.

306. After having passed over the first dike, and crossed the *Oste* in a boat, I proceeded on the second dike to the village of *Basbecke*, where I again entered on the *geest;* and travelling over it 2 miles in the direction of the river, I came to *Newenhaus*, another village, situated near a small gulph into which this stream discharges itself. The dikes along the river side are a continuation of those that border the coast in front of the new lands, and also encompass the gulph. Three-masted

vessels, ascend, with the tide, almost as high as *Bremer-Vohrde;* but though *Newenhaus* is properly the port of the *Oste,* it is built partly on the dike and partly within it, and communicates with the sea only by a canal with a double sluice affording passage to the small barges employed in loading and unloading those vessels which do not ascend so far as to the port near *Bremer-Vohrde.* I staid this night at *Newenhaus.*

307. I spent the following day in observing the coast of the extremity of the peninsula to the westward of the *Oste;* and first I went to *Atrendorff,* which is likewise situated at the head of a small gulph, the lower part of a vale wherein flows the little river *Medem.* From *Newenhaus* to this place there is again a great extent of very fertile *new lands,* secured against the sea by dikes, within which I travelled. *Atrendorff,* a small town, standing also within the dikes, and communicating with the sea by a canal with sluices, possesses the true Dutch neatness, which indeed I observed in all the villages situated at the extremity of the great canals; whence it appears probable that the *marsches* of this part of the peninsula have likewise been enclosed with dikes, and cultivated by colonies of the Frisians or the Dutch; for nothing of a similar kind is to be seen in the interior part of the country.

307. *a.* I walked on within the dikes as far as they extend on the *Ritzenbuttle* side. This enclosed

space, which is of considerable breadth, resembles the valley of the *Oste*, being interspersed, in the same manner, with slips of *geest*; it is in the intervals of these that the soil has been raised and levelled by the sediments of the land-waters and of the tides. The low spaces are intersected with ditches opening into large canals, which cross the dikes with sluices, and carry the land-waters to the sea; each canal having at its extremity a village resembling those already described. Throughout the whole of this tract, as well in the *geest* as in the *marsch*, I observed the highest degree of cultivation.

308. Before I quit this coast, which I have shewn to be perfectly similar, with respect to general phenomena, to the many others that I described in my former Travels, I must make one general remark. These observations on the *new lands* added to our coasts overthrow all the chimerical systems, in which, for want of real *causes* to explain the origin of our *continents* and the state of their surface, it has been attempted to assist such causes as are obviously themselves deficient in power, by ascribing an incalculable *antiquity* to the *continents* on which they act; and to this has been added lately the hypothesis of partial elevations and subsidences. All these systems, I say, are subverted by a circumstance observable on all *coasts;* as appears, not only from my own immediate observations around great part of the continent of *Europe*, and

of the island of *Great Britain*, but from the descriptions of travellers in general, namely, that these *new lands*, whatever be their breadth, do everywhere extend *horizontally* towards the *sea*, and require to be secured with dikes against its invasions during high tides. This is, in the first place, an incontestable proof that, since the *sea* has changed its bed, (or, in other words, since the birth of our *continents*,) no alteration has taken place in its level; and that consequently this great event has not been produced on our globe by *slow causes*, as had been assumed in various systems, but by a sudden *revolution*. With respect to the remoteness of this epoch, it has here been shewn, by a new example, that these *lands*, while successively increasing, have almost everywhere comprehended within them historical monuments, which afford a complete demonstration that our *continents* cannot have existed during any very great number of ages.

309. My last journey in the peninsula of *Bremen*, which took place in June, 1799, was with the particular view of visiting the district where, as M. Wolsmann had told me, most of the *blocks* had been found which are employed in constructing the long dike against the sea extending from *Cuxhaven*

on the western side. This district is that of *Buxtehude*; and it was from the immediate neighbourhood of *Hornburg* that the greatest quantities of blocks had been brought. I set out on this journey from *Berlin*, and passed through *Mecklenburg* to *Boitzenberg*, above *Hamburg*, on the right bank of the *Elbe*. The road being one which I have elsewhere described, I shall only begin at present from this part of the borders of the *Elbe*, where will appear another example of the operations of that river on its banks since the time when it began to flow.

310. At *Boitzenburg*, a promontory branching off from a hill of *geest*, (by which I always mean the *original soil* of the country,) advances to the borders of the *Elbe*, across low grounds; and the whole space here presents chronological monuments of various kinds. The river, on looking up it from the higher part of this eminence, appears, by its direction, to flow immediately towards *Boitzenburg*, which is built on the foot of the promontory, within a creek formed by the lower part of a vale. At first indeed the *Elbe* did take this course; for at the extremity of the promontory there are some ancient *cliffs*, which still continue, in some places, to crumble down; but in others they are covered with grass, the alluvial soils formed along this part of the bank having repelled the river, and turned it in a different direction.

11. Having ascended this promontory from the
n, I met with a new instance of what I have
re asserted, that the *sandy strata* participated
he latest catastrophes of the *stony*, whereon
had been formed beneath the waters of
sea. My ascent was by a hollow road, which
bited on both its sides the section of *sandy*
ta descending rapidly towards *Boitzenburg*,
shewing their upper section at the top of the
whence it appears that they, together with
stony strata which undoubtedly are covered
hem, must have undergone an *angular move-*
t, at the time of the *subsidence* whereby was
luced the above *vale*, which slopes down from a
nce towards *Boitzenburg*.

12. I observed many *blocks* on this hill; and
having crossed its summit, I came within
of a very extensive tract of *alluvial land* formed
g the *Elbe* the whole way to the distant hill of
enburg, between which and that of *Boitzenburg*
wide vale. Through this vale flows the small
r *Stecknitz*, whereby, as I have mentioned in
Travels lately published, a communication has
formed between the *North Sea* and the
tic, by means of a canal with sluices, which is
ied on to *Lubeck*. The hill of *Lauenburg* is
rated on the western side, by a low space co-
d with heath, from a branch of another hill,
reon stands *Escheburg*. This promontory does
come quite down to the *Elbe*, but has before

it a considerable extent of *original* low ground which, along the river side, has received the addition of an *alluvial soil.* I continued to observe, on the heights, *blocks* of *primordial stones* in great abundance.

313. Having reached *Escheburg*, I went down on this low ground, and continued to descend the course of the *Elbe* as far as *Zöllen-Spicker*, on a dike which encloses lands of the greatest fertility, partly cultivated, partly forming meadows and orchards. On the outer side of the dike is an extensive tract of *fore-lands*, a name given in these countries, as I have elsewhere explained, to the alluvial grounds which are formed subsequently to the erection of the dikes: in the parts nearest to the latter, this tract is planted with willows, while the rest affords a rich pasturage in summer, and in the beginning of autumn; it is still sometimes inundated during the great swells of the *Elbe*, but its soil continues to increase in height, because the sediments of the river are retained by the grass with which it is covered.

314. At *Zöllen-Spicker* I embarked with my chaise in a boat, and crossed the *Elbe* to *Hope*, on the left bank, 3 miles and a half above *Harburg*, towards which place I then proceeded by land. I travelled a long time through rich orchards and cultivated grounds enclosed between two rows of dikes, the outermost row serving to secure them against

the attacks of the main river, and the other against the inundations of the waters which descend from the hills, and are conducted to the *Elbe* across these soils by canals bordered also with dikes. After proceeding a certain way, I passed over the innermost dike, and crossed a promontory of *geest*, which bore nearly a similar appearance. I have already said that this soil is in itself very barren, but may be easily fertilized by cultivation, when manure can be obtained; as is the case here, because of the vast tract of meadows extending from the foot of the hills to the innermost dikes of the alluvial soils: thus all the part of these hills over which I travelled was cultivated; and I now began to observe, along the sides of the fields, and in the villages, a great quantity of *blocks*.

315. The whole tract of low-soil, which follows the *Elbe* as far down as *Harborg*, is a *moor*, as it is called in this country, that is to say, a *peat-ground;* its breadth, in some parts very considerable, extends from the foot of the hills to the inner dikes of the *marsches*, or alluvial lands, which border the river. The undermost part of this soil consists of the same *sand* as the hills; and after it had been levelled by the waters descending from the latter, and by the sediments of the *Elbe*, the *peat* being formed on it, and overspread with heath, the surface was so much raised, that, a limit having been thus put to the inundations of the *Elbe*, the *marsch*, composed of the argillaceous and marly sediments of that river, was formed on the *peat*, which there-

fore extends, throughout this whole space, under the *marsch* and its present dikes, and passes even beneath the mud on the bed of the river; indeed the inhabitants do not doubt, that, as the *peat* increases in the *moors*, it still continues, when softened in rainy weather, to flow under the *marsch* and its dikes down to the bed of the *Elbe*. In my Travels in *England*, I have described the same circumstance on the coast of *Somersetshire*, and on that of *Torbay* in *Devonshire*. The waters of these vast *moors* being however led across the *marsches* by canals, into which that of the river, when most swelled, is prevented from ascending by the sluices placed at their terminations, the surface of this tract is covered with good herbage: in the most inland parts, over which the sand of the hills is scattered by the winds, there are good hay-fields; the rest forms excellent pasture-ground, where I saw abundance of cattle, and young colts of a handsome breed; moreover, in some parts of these pasturages, the *peat* is cut for fuel.

316. I changed horses at *Harborg*, and thence proceeded to cross the district from which, as I have already said, have been brought the greater part of the blocks employed in bordering the extremity of the peninsula, to the west of *Cuxhaven*, for the purpose of securing it against invasion from the sea; this district extends inland about 4 German miles. At *Harborg*, a large vale opens, and rising insensibly between the hills, it separates, at a little distance from the town, into two branches,

one of these ascending to *Buxtehude*, and the other, which is longer, reaching all the way to *Hornburg*. The main vale and both its branches are covered with fine hay-fields, and the slopes on their sides have been planted to a great height with young trees, chiefly oaks and beeches, which already form a very extensive wood. No heath remained here except on the summits, where I saw many blocks rising above that plant; and in order to observe them, I ascended the highest of the hills. In viewing these *blocks*, I should not have guessed that there were among them so many beautiful varieties of stones as I had seen at *Cuxhaven*, for, being covered with *lichens*, they all bore a similar appearance: they had been left on these heights, because their removal would have been attended with too much expense; and besides, sufficient quantities had been found on the slopes, and on the bottom of the vales, whence it was easy to carry them down to the *Elbe*, and to ship them at *Harborg*. The stone dikes constructed near *Cuxhaven* have therefore been of advantage, not merely by protecting the new lands at the extremity of the peninsula, but also by rendering productive a large space, which formerly yielded nothing but heath, but is now covered with good meadows, and woods of the most valuable trees.

817. My intention, in coming hither, had been to contribute, by the details into which I have just

entered, to determine what was the *original state* of this part of the continent, and what change, leading to the final obliteration of the above geological monument, has been effected in it by the labour of men. It may have been seen in my former Travels that this is a subject to which, in various places, I have very diligently attended, because it presents many different *chronometers*, arising from the several wants of the new settlers, who have progressively taken possession of uncultivated soils of different kinds.

318. In returning to *Berlin*, I wished to cross the *Elbe* at a higher point of its course; because as, in my plans of future observation, this *river* would frequently lie in my road, and as it was also one of the largest in these countries, I had particularly made choice of it for the purpose of studying its operations on both its banks. With this view, having returned to *Harborg*, I proceeded towards *Lunenburg*, lying five miles above it near the same river. I passed first over a part of the hills from which the *blocks* have been cleared away, and which, though they have no other soil than the *geest*, so barren when left to itself, present evident proofs that, when the farmers are properly assisted, and have meadows within thei reach, this soil may be rendered very fertile. Within this space are the villages of *Matelfeld* and *Lüse*, in which I saw some *blocks* still remaining.

319. I came

319. I came next to a low damp soil of great extent, interspersed with alder bushes; and this was succeeded by another large space, which rose very little above it, but was covered with heath: the latter belongs to the inhabitants of some villages lately built in the neighbourhood, who pare this heath, and carry the turf, after it has lain for some time in heaps, to serve as dressing for the lands recently brought into cultivation. It is not probable that any *blocks* have been removed from this space, because there is no river by which they could be carried down to the *Elbe;* yet I perceived but very few, either in the heath or in the villages. I then proceeded to *Wolburg*, two miles short of *Lunenburg*. The *blocks* were here more numerous; and likewise more various in their kinds, than on the soils immediately preceding: among such as were common elsewhere, I observed some of a perfectly white *granulated quartz*, while others of the same stone were of a semi-transparent bluish grey; of the latter, some were throughout of one uniform tint, and others consisted of *strata* of different hades. After I had passed *Wolburg*, the number f the *blocks* increased: the heaths extended ll the way to *Lunenburg;* they were pared, ecause there were villages of new settlers near hem.

320. As I crossed a hill before I reached *Lunen*-*urg*, I saw from its top those two extraordinary nonuments of the catastrophes of the *strata* in

this country which I described in my first Travels. In the middle of this vast tract of land, where no strata appear at the surface but of sand, there rise, near each other, two *mounts*, one of *gypsum*, the other of *chalk;* and from the foot of the former issues a spring of water, which is so fully saturated with *salt*, that it is ready to be thrown into the boilers, whither it is immediately carried. Of the mount of *chalk* I formerly took the more particular notice, because it was the first that I had seen throughout the whole of the extensive tract of *sandy* strata over which I had passed, although the *flints* belonging to *chalk* are everywhere scattered on the surface in such abundance: I afterwards met with another at a great distance from this spot, between *Aix-la-Chapelle* and *Liège*, which I have had occasion to mention in the second of the journeys related in the present volume.

321. The town of *Lunenburg* is situated in a vale, through which flows the small river *Ouwe;* the road leading from it towards the *Elbe* does not however lie through this vale, but over several ridges of hills, the first of which, though heath is its only spontaneous product, is partly cultivated, and partly planted to a certain breadth with woods of oaks: I saw here very few *blocks*. After I had passed the woods, I was struck with the extraordinary appearance of the rest of the ridge; its surface reminded me of the sea when violently agitated: no attempt, therefore, had been made to bring it

into cultivation, which would be attended with too much expense in levelling the higher parts, and filling up the hollows. This is an indication of very great convulsions in the *stony strata* beneath those of *sand*; nor ought it to appear surprizing, after what has been seen of their strange disorder near *Lunenburg*. This space is therefore still a heath; but in order to make some profit of it, acorns have been sown, and have sprung up and grown in the hollow parts, where there is the greatest humidity. These plants will never become trees because they are browzed by the sheep; but they form brushwood, and are cut for faggots. From this tract of broken ground, where no *blocks* appeared, I proceeded to a large space which had subsided, and on the slopes of which I saw a considerable number: in the cultivated parts, where, when the fields had been cleared, the *blocks* had been removed, I observed a great many lying by the sides of the road.

322. I next ascended the opposite hill, and saw on its slope abundance of *blocks*, in concavities of the kind which I have already described in various parts of these countries; being apparently focuses of explosion, where the interior *fluids* (when, within the caverns which had occasioned the rupture of the *strata*, they were violently compressed by the *subsidence* of the separated masses) threw out on the surface fragments of the various inferior classes. On the summit of the hill itself, there were no blocks, but I again saw many, with

great quantities of smaller stones, on the opposite slope, as I descended towards the village of *Netz*, through which passes a brook employed in turning a mill. Beyond this, the ground rises; for a certain way it forms a heath, where some parts being cultivated the rest is pared; but afterwards I entered an extensive tract, in which the *sand* is so loose, that, but for the *carex arenaria*, all its strata would have been carried away by the winds; a part of it, however, has been preserved by this plant, and is accumulated in *dunes*, as on the sea-shore; for this is the very same kind of sand which covers the bottom of the *sea*.

323. From this heath, there is only a small descent to a horizontal space, about a league in breadth, but extending on both sides farther than the eye can reach, between the foot of the hills, and the alluvial soils which border the *Elbe*. This space will afford a new example of what I said in my *Travels on the coasts of the Baltic and of the North Sea*, concerning the formation of *peat*; that, though the *antiseptic* quality of the waters occasioning the conversion of *vegetables* into *peat* appears very certainly to proceed from the *soils* over which those waters flow, it still remains a mystery by what part of the soils this effect is produced; an object well worthy to be followed, in many different places, by chemical analysis. Here, as is the case lower down on the course of the *Elbe* on the same side, at *Hope*, *Harborg*, and *Stade*, the hills which descend towards the river, together with the grounds

at their feet, consist of *sand*, whereof *heath* is the spontaneous product; now it has been seen that all the low soils which I have hitherto described within this tract are *moors*, that is to say, *peat-mosses;* and the waters flowing in them, though transparent when taken up in a glass, appear brown wherever they are seen at any depth, and deposite a brown powder on the sand over which they pass: while the low space now in question, though the apparent circumstances are the same, is covered only with grass growing on the *vegetable earth* produced by its annual decays: it forms a good pasturage, interspersed with alder bushes; and the rivulets which cross it are perfectly limpid, effecting no change in the colour of the sand.

324. After passing over the above space, I came to an *alluvial soil* but little below its level; this soil is a league in breadth to the dike which borders it on the side next the *Elbe*, and is crossed on a causeway of sand covered with large stones, of equal height with the dike. Notwithstanding the care bestowed on the cultivation of this rich soil since it has been enclosed, the indigenous plants, of which the roots are below the reach of the plough, are not yet extirpated; I saw here and there some tufts of reeds, amidst the finest rye and wheat. After I had passed over the exterior dike at a point where a small village had been built on it, I was a quarter of an hour in crossing a tract of *fore-lands* before I reached the actual course of the river, in a part where the boats be-

longing to the village were then lying. Here I again saw what I had remarked elsewhere on the course of the *Elbe;* that, though the soil within the dike is composed of the *argillaceous* and *marly* sediments of the stream, this exterior soil consists almost wholly of *sand;* and its surface is furrowed, being exposed to the action of the waves, which spread over it when the level of the water is higher. The cause of this difference in the soils is that, in the promontories attacked by the *Elbe* in its course, strata of *clay* and *marl* are intermixed with those of *sand:* the abrupt extremities of these promontories having crumbled down, the river, in its inundations, has carried along with it the fallen materials lying at their foot; but these materials have subsequently separated from each other; the masses of *marl* and *clay*, being diluted by the *Elbe*, have spread across its whole channel, and have been deposited at the bottom of the calmest water on its borders; while the *sand*, having followed the stream, has been deposited on its bed, where in some parts it has accumulated so much as to form many islands. Since the rich soils on the sides have been enclosed with dikes, for the purpose of bringing them into cultivation, the river, being thus confined within a narrower space, has carried on to the sea the *marly* and *argillaceous* particles with which its waters have continued to be loaded; and the waves and the tides have there spread them to a great distance along the coasts. In consequence of this contraction of the space which the *Elbe* occupies between the dikes of its opposite shores, and above the reach of the tides, the stream is become more rapid, and the sediments deposited by it on the outer side of the dikes now consist chiefly of *sand.*

325. Here I crossed the river, and landed with my chaise at a village below *Boitzenburg,* to which town it was necessary to send on for post-horses: while I was waiting for them, I ascended a branch of a hill terminating in a cliff near the village; and having gained its summit, I saw that *Boitzenburg* stood on an insulated eminence of *geest,* anciently an *island* in a creek which was formed by the lower part of a vale arriving thither between two promontories. This eminence was formerly encompassed, during floods, by the waters of the *Elbe;* but as it lay out of the course of the main stream, which flows round the promontories, it soon ceased to be thus an *island,* because the soil around it was raised by the sediments of the river: this soil is very rich, and is guarded by a dike of *blocks* against the inundations of the stream.

326. The *cliff* under which I had landed was still continuing to crumble down, though no longer in consequence of the attacks of the *Elbe;* as there has been formed before it a broad strand of gravel whereon the village stands: but the waters arriving from the upper part of the hills during rainy seasons flow down this cliff in rills which furrow its surface, and thus cause the *sand* to fall, and accumulate on the strand at its foot; it was overspread

with the *carex arenaria,* and under the shelter of that plant, others were already beginning to grow; so that, in a little while, this *cliff* also will certainly be reduced into a slope covered with vegetation.

327. As I looked down the *Elbe* from the top of this hill, I could follow the stream itself but a little way, on account of its many windings; I traced its course, however, between the hills, by the tops of the *cliffs,* sometimes on one of its banks, sometimes on both; among these I saw several which were reduced into slopes, and covered with grass; but others were still crumbling down in the upper part. Now it will be seen that the case is the same along the course of this river, throughout the whole space where it flows between these sandy hills, extending a considerable way into *Saxony;* and it must have acted in this manner against all the promontories which at first obliged it to bend too suddenly, and which, as they consist like the above, only of *strata* of *sand, marl,* and *clay,* the attacks of the stream have been able to demolish; for these promontories, in consequence of the *subsidences* that produced the succession of *vallies* and *plains* in which the *Elbe* flows, originally presented towards it abrupt extremities; and wherever it has been carried against them by too direct a course, it has sapped their foot, and occasioned them to crumble down, either till it has at last sufficiently widened its curves, or till the cliffs have acquired the protection of the natural dikes which

their own fallen materials have formed at their foot. All the substances light enough to float for some time in rapid water have been carried down by the current, and then deposited in those parts where the river, finding room to spread, loses consequently its rapidity: thus have been formed all the *alluvial soils*, which I shall continue to describe in relating my subsequent journeys along the upper part of its course: this stream has raised on its bed some *islands* consisting chiefly of sand; while the argillaceous and marly particles, which it carries into the sea to a considerable distance, being afterwards repelled against the coasts by the waves and the tides, have produced not only the *new lands* lately mentioned on the eastern part of the extremity of the peninsula of *Bremen*, but likewise those which, in my Travels last published, I described more particularly along the coast of *Holstein*, and a part of that of *Sleswigh*.

328. In my return to *Berlin*, I took a straiter road than that through *Mecklenburg*, by which I had before proceeded to *Boitzenburg*. From the latter place, my first stage was now to *Lübthen*, at the distance of 3 miles. On setting out from *Boitzenburg*, I crossed on a causeway, composed of sand, the lands enclosed by the dike which I mentioned; and I came to a plain where the *sand* was in some parts loose, but in others covered with turf, or planted with pines and birches. This sand is mixed with small gravel, amongst which

there are *flints;* but I observed no large stones, till after travelling 2 miles, I came to a village of *Brasdorf*, where I saw many *blocks.* Beyond this, I found the soil improve; it was cultivated in some places, and in others it was planted with woods of oaks and beeches. This is again a plain, and its lowest parts are meadows planted with willows. For some way, I continued to see *blocks* in considerable abundance; but at last they disappeared; and at *Lübthen*, whither probably had been brought all the stones which could be collected in the neighbourhood, there were no *blocks*, nor was the street paved except along the sides of the houses.

329. My second stage was to *Lenzen*, which is at the distance of 4 miles and half; I was nine hours on the road; for it lay, almost the whole way, over loose *sand*, occasionally interspersed with *dunes* and small birches. The next stage, 3 miles in length, was to *Perleberg*. Within this space, which is mostly a plain, the soil is much more fertile. Along a great part of the road, I saw scarcely any *blocks;* but in the village of *Nebelin*, and some way beyond it, they lay in considerable abundance.

330. From *Perleberg* I set out for *Kyritz*, at the distance of 3 miles. In this stage, the ground soon rose, and became less fertile; there were many uncultivated spaces which had been planted with pines

d birches; and at the top of the hill, I found thing but loose sand, with some pine woods. I w few blocks till I reached *Döllen;* but from that lage to the end of the stage, there were great antities of them. From *Kyritz* to *Fehrbellin,* hich is a distance of 4 miles, the soil is better d more generally cultivated; only a few blocks ere lying here and there, at considerable distances om each other; but I saw many collected together t the village of *Prozen,* whence I descended into very extensive *peat-moor,* in which very good eat is cut, and which, as the *peat* is only a few et in thickness, serves at the same time for pasurage. The road from *Fehrbellin* to *Bützow,* 4 iles distant, passes over some high ground comanding this large *peat-moor,* which is in every art intersected with ditches, leading the waters owards a canal, where I saw some small boats ailing along; by this canal the peat is conveyed the *Havel,* near *Spandaw,* whence it is carried p the *Spree* to *Berlin.*

331. The stage from *Bützow* to *Berlin* is 3 miles length. After travelling for some way through eadows, of which the soil had been formerly velled by the *Havel,* I crossed that river on a idge. Hence ascending new hills of *sand,* I came one of those ancient forests which are still reaining in some parts of *Brandeburg* and *Meckburg,* and which, in my eyes, have a venerable air, having been always left in the hands of nature;

nor does it appear that any of those produced by art are likely ever to resemble them. These forests consist of *oaks*, *pines*, and *birches*. The *pines*, having had full liberty to spread their branches emulate the *oaks* in the variety of their antique forms, while in other respects they are finely contrasted with those trees: the boughs which they throw out are very dissimilar to their dark and deeply furrowed trunks, being seen, in such parts as are not concealed by the multitude of their green tufts, to be covered with a smooth orange-coloured bark. The *birches*, which are intermingled with these, have a very majestic appearance; their ribbed trunks, covered with a white pellicle scored across, and thus variegated with dark brown, rise to a greater height than those of the other trees; and from their summits hang elegant clusters of branches, divided into small twigs, which, when in summer they are adorned with their light and beautiful foliage, are pendent almost to the ground. In this latter part of my road to *Berlin*, I saw very few *blocks*.

332. I have already explained how strongly every idea of the *migration* of *blocks* on our *continents*, since the latter have been abandoned by the sea, is opposed by the alternate abundance and deficiency of those masses in successive spaces contiguous to each other; and I have also shewn the importance of banishing this error from Geology. I have therefore no apprehension that any of those who study nature in pursuit of truth will accuse me

of prolixity, on account of these details respecting my various journeys through the *peninsula* of *Bremen*, this being a tract into which it is impossible hat *blocks* can have been transported from any quarter whatever, and in which, as this great phenomenon here presents itself under a great variety of forms, I have had an opportunity of pointing out many of its essential characters. But, in order to become acquainted with all these characters, it must be viewed in its associations with other geological phenomena, on both mountains and hills composed of *stony strata*, that thus may be formed a more accurate judgment of the connexions subsisting between all the monuments, however different in their nature, of the causes which have heretofore acted on our globe. Various circumstances regarding these connexions have already been detailed in the two first of the journeys contained in the present Volume; but, in forming the plan of my observations, I had considered it as essential to extend them into several different countries, for the purpose of effectually removing all doubts on the subject. I shall therefore resume the narration of my Travels, in which I shall henceforth follow the order of their dates, beginning with the excursions proposed to me, as I have already said, on my arrival at *Hanover* in 1797, by my friend L. Von Pape, who himself accompanied me in the first, together with Madame Von Pape and Madame [illegible]ermann.

EXCURSION *from* HANOVER *to the Hills of* *Mineral waters of* REHBURG.

AUG. 24*th*. 1797. We set out from *Ham*
at 7 in the morning, and went first to *Hagenb*
4 miles distant, where we changed horses.
road lay through a sandy plain, in which I
some cultivated spots, but the greater part was
occupied by heath. For a considerable way,
thing appeared in the *sand* except the usual p
cles of *white quartz;* but by degrees I perceive
to be mixed with a *gravel* of *primordial st*
chiefly *granite;* and at last, I saw some *bl*
many of them were collected together in the s
town of *Wunstorf*, through which we passed;
these stones were employed there in paving the str
Afterwards the plain became more fertile, the
tivated spaces were of greater extent, and t
were many new plantations; though I still saw
which were covered with heath.

333. After we had passed *Hagenburg*, I
marked a change in the soil; the scattered st
instead of being of the primordial kinds,
fragm

gments of *sand-stone;* and as we approached
hills of *Rehburg,* I saw some small *rocks,*
ing here and there above the *sandy plain.* This
s another of those monuments of the catastrophes
the *strata* which the labour of man was begin-
ng to destroy. The *rocks* that are found in
ins, and consist of the same *strata* as the neigh-
uring eminences, while they thus exhibit ruins
those *strata* covered with a more recent soil,
arly evince to us that the *eminences* themselves
e such, only because the rest of the *strata* have
ided around them. I approached these rocks,
d found them to be masses of *strata* of a *grey*
d-stone proper for building, of the same nature
the fragments scattered on the soil: the hills
mselves are also composed of this stone; but
ng less conveniently situated for carriage than
e rocks, I saw men at work in cutting away the
ter; so that perhaps, by this time, these inter-
ing monuments may have been entirely demo-
hed. We arrived at *Rehburg* at 1 o'clock.

334. These hills will present an additional ex-
iple of what I have already shewn in various
ices; that though, as above, the labour of man
s destroyed many geological monuments, it has
wever laid open to view a much greater number
such as otherwise would have remained unknown.
ere it not for human labour, we should never have
scovered the disorder of the *stony strata* in the in-
ior part of many hills, of which the external

forms are softened, and the surface is covered by vegetation, on a *loose soil,* frequently of unknown depth. A very pretty village has been built here, on account of the baths, which are in a high vale encompassed with eminences covered with fine beech woods, where very pleasant walks have been cut for the company frequenting this place; on the edge of the woods, these walks open on a great variety of beautiful prospects. The hills, up to their summit, are all covered with the same *heath sand* which prevails on the neighbouring plains. I saw in the woods some *blocks* of *granite,* but many more of the *sand-stone* that composes the mass of the hills: on examining the latter, I perceived on some of them impressions of *plants,* which would have led me to suspect that a bed of *coal* was contained in the hills, even though I had not been informed that one was actually worked here. Above the surface, there rose a few small rocks of the *sand-stone,* the *strata* of which dipped strongly inwards, and presented their section at the top.

335. I descended into the vale where the *coal-pits* are, and obtained from the colliers the following information. This bed of *coal* is so much inclined, that while, in one of the pits, it has been found 30 feet below the surface, in another, at no great distance, its depth has increased to 50 feet; it is here five or six feet in thickness; but in other places it is reduced to one foot: when followed it is found to be interrupted by fractures: now it will

be seen that the state of the *stony strata* that cover it corresponds with these symptoms of catastrophes; and that, besides, these *strata* afford a proof that the *vegetable* substances over which they were formed, and which must certainly have been accumulated above the level of the sea, had subsequently passed below its level, and in that situation had been *mineralized* into *coal.*

Aug. 25th. Count BENTINCK VON BUCKHORST, who, having been some time at *Rehburg*, was well acquainted with the country round it, was so good as to accompany me in an excursion over these hills, in order to shew me the spots which would more particularly interest me. We set out in the morning, and ascending a hill by one of the valleys in the wood, we came to the upper part of its southern slope, whence we went down to some quarries opened on that side, in *strata* of the same *sand-stone* as that of the small rocks which I had seen rising on the plain, and the large fragments which were scattered on the slope of the hill.

336. The mass of *strata* worked in the first of the quarries which we entered was about 20 feet in thickness; these strata descended so much more rapidly than the slope of the hill, that they disappeared under the loose soil of that slope. In this first quarry, all the *strata* were intersected by a *fracture*, and the master of the quarry told us that their inclination which was about one foot to

three, was greater on one of its sides than on the other; so that, when the stone was followed to a greater depth, the same *strata* were found to differ several feet in level.

337. Besides this, there must be other fractures in that part of the hill where the *strata* are not exposed to view; for, on entering another quarry on the same side, we there saw, not only that they were less *inclined,* but also that they had a different direction. This quarry had already been worked to too great a depth to allow the pumps to raise up to the surface the water appearing at the bottom, which was therefore discharged by an *adit* opened for that purpose on the slope of the hill; respecting the course of this *adit,* we obtained from the master of the quarry the following information. The *sand-stone strata,* through which it was carried at first, being much more inclined than the slope of the hill, were succeeded by the accumulations of fragments, some of them rounded, which compose this slope; and through these it has been continued with the assistance of *props*: in some places, the depth of this *adit* below the surface is not less than 50 feet; but the *strata* of *sand-stone* are not met with again in its course, because they pass considerably beneath that level.

338. The stone worked here, which is very hard, is of a light grey, with an ochreous tinge in its fractures; and though its *strata* are parallel with

each other, the line of their junction is undulated. In the lower *strata* are found here and there impressions of *leaves*, all belonging to the same plant: these leaves are three or four inches long, and appear lopped at the extremity; they are about half an inch in breadth: but being narrower at the end next the stalk, their veins, which are strait and strongly marked, give them a resemblance to small fans when closed. Beneath these *strata* of *sand-stone*, are others of indurated *clay*, containing the same kinds of *ferruginous concretions* which accompany the *beds of coal* in *England*, where they constitute the principal *iron ore*. Under these is at last found the immediate *roof* of the *bed of coal*, consisting of *strata* of indurated *clay* mixed with *sand*, together with others of a bluish *schistus* which easily breaks between the fingers; and all these *strata* are full of the *leaves* described in those of the *sand-stone*, affording an evident indication of the *vegetable* origin of this *bed of coal*, namely, that it was an ancient *peat-moss*. The other important circumstance to which I alluded, as proving this *peat-moss* to have passed below the *waters of the sea*, and to have been there *mineralized* into *coal*, is, that all the *strata* bearing impressions of this plant, from the lowest of those of the *sand-stone* downwards, contain abundance of small *chamæ*, and some *helices*.

339. From *Rehburg*, we accompanied M. Von Pape to visit his friend Abbot SALFELD, at the

Abbey of *Lockum*. In our way thither, we first ascended, through woods, the hills of *Rehburg*, on which we then proceeded over commons extending all the way to its opposite slope; here also these hills are covered with *heath-sand* down to an unknown depth; but in some places there are small quarries in rocks of the *sand-stone* which rise through the *sand*, like those already described in the plain at some distance. On all these eminences I saw a great many scattered blocks, chiefly of *granite*, but some were of the same *sand-stone;* wherever the soil was cultivated, the *blocks* taken out of it were lying in rows along the side of the arable lands. These are all so many effects of the catastrophes of the *strata*, the state of which in the mass of the hill has been seen above: and that this hill is become such only by the *subsidence* of the grounds around it, is proved by a *lake* at its foot, in the middle of which is a rock called *Wilhelm-stein*. This *lake* occupies the lowest part of a large vale covered with *peat*.

340. Abbot Salfeld was so good as to shew us the abbey, which was built in the eleventh century for a monastery of Benedictines; but it is now a Lutheran collegiate church, under an Abbot and Prior. This abbey stands on a branch of a hill advancing into the peat-moss, which, at this season of the year, presented a very beautiful view. The lower parts of the hills covered with woods formed a rich irregular border to a verdant vale inter-

sected with ditches, by which, during the summer, the surface is drained of all superfluous moisture, though enough still remains to afford constant nourishment to the grass; and the peat-moss is thus converted into a tract of fine meadows which are mown for hay. We returned to *Hanover* the same ay.

341. The other plan proposed to me by M. Von ape was one in which he had it in his power to fford me much assistance; for the residence of is son-in-law lay in the road, and his eldest son, a member of the Council of the States, offered to accompany me throughout the whole excursion: to this proposal I agreed with great pleasure, and it was executed not long afterwards. But first I had engaged to accompany Madame Zimmermann to *Brunswick*, to visit a gentleman whom her deceased husband had frequently mentioned to me in terms of the highest praise; this was the late General Von Stamford, for whom, from that period to the end of his life, I ever entertained the most sincere respect and esteem; and my friendship with him and his amiable lady induced me subsequently to make long residences at *Brunswick*, at different times.

EXCURSION *from* HANOVER *to* BRUNSWICK.

AUG. 28*th*. 1797. We set out in the morning from *Hanover;* and after we had passed through *List*, a village not far from that town, we came upon horizontal soils, covered with heath growing on peat of little depth, of which, in these sandy plains, there are very extensive tracts. As far as *Warmbücken*, I saw on the sand, wherever it was uncovered, large *blocks* of *granite*, and a great many were collected together in that village; but from thence to *Burgdorf*, where I got out in order to lighten the carriage, which the horses could scarcely draw, because the road was in loose sand, I perceived hardly any blocks; and at last they entire disappeared. This was a part of that road *Zell*, where I mentioned before that the *sand* c tained only some particles of *white quartz*, an few *flints;* as I was now on foot, I observed latter more particularly, and saw that they of a great variety of shades, from black to w and some, which were semi-transparent, were colour of cornelians.

342. At *Burgdorf* we were to change horses; but, on account of the harvest, it was a long time before we could obtain fresh ones; I had leisure, therefore, to examine the pavement of the village, which was formed of various primordial stones, and of granulated quartz. In travelling from hence to *Brunswick*, a distance of 5 miles, I saw only a very few *blocks* of *granite* along the sides of the fields. I have described this road, because, as the *granitic* summits of the *Hartz* here appear on the horizon, I have thought it important to shew that, with respect to the alternations which occur in the dispersion of the *blocks*, no difference is observed in approaching those mountains.

JOURNEY *towards the Western foot of the* HARTZ, *through* NORDHEIM *and* CATLENBURG.

SEPT. 7th. 1797. I set out in the morning from *Hanover* with M. Von Pape and his eldest son, and we proceeded together to *Catlenburg;* the Amtmann of which place was M. WEDEMEYER, son-in-law to the former of these gentlemen.

343. The point of the country where *Hanover* is situated is very remarkable, as being that of the division of soils which differ greatly, both in themselves, and in the nature of the *blocks* disseminated on their surface. In quitting the town before, on the northern side, I had immediately entered on those vast tracts of *sand* covered with heath, in which, the whole way to the borders of the *Baltic* and of the *North Sea,* scarcely any *stony strata* are exposed to view: this soil extends very far westward, and consequently to a great distance from all *mountains* composed of *primordial strata;* yet it is strewn with *blocks* of primordial stones, in various quantities, the abundance of which bears no proportion to the greater or less remoteness of those *mountains.*

mountains. But now, coming out of *Hanover* on the southern side, and entering the country of *Calenberg*, which extends as far as *Göttingen*, I found a soil of a quite different nature. About a league's distance from the town, the *sand* disappears at the opening of a large *valley*, bordered with mountains composed of *strata* of *lime-stone*; which strata are also found at but little depth beneath the soil of the *valley*. Now although the chain of the *Hartz* is here at no great distance on the south-east, and though the torrents descending from that chain, and contributing to form the river *Leine* which flows in the large *valley*, arrive through lateral vallies, no more *blocks* of *primordial stones* are here to be found; those scattered on the surface in great abundance being all of *lime-stone* and *hard sand-stone*.

344. The road, which is kept in very good order, was for some way gravelled with fragment of *sand-stone*, and afterwards of *lime-stone*; the latter was broken without difficulty, its *strata* having all been shattered in the *subsidence* which produced the valley; a catastrophe manifestly shewn by many hillocks formed of such masses of these *strata* as happened to remain above the level of the rest. In many parts, this *valley* widens so as to form small plains; but afterwards, its sides again approach each other. I particularly observed this latter case near *Einbeck*, where a branch of a mountain advances so far forward on the western side, as to confine the river within a defile. We

passed over this promontory, which bears the most evident marks of the catastrophe whereby the valley was produced. The side next *Hanover* being very steep, a winding road has been cut in it; and in many places where the *strata* are thus laid open, they are seen to be strongly *inclined*, and to present their *section* at the top. Now, as these *strata* contain a great quantity of *marine bodies*, and must consequently have been formed on the bottom of the sea in a situation nearly *horizontal* and *continuous*, it is not possible to doubt that the *valley* was produced by a *subsidence*, which, together with all the other great catastrophes of the *strata*, took place antecedently to the birth of the continent.

345. From the top of the hill of *Einbeck*, I had the most interesting view of the various effects of these catastrophes, which appear in the projections and retreats of the rocks in the sides of the valley, and their several terraces, either covered with woods or grass, or else cultivated on the soils of rubbish composing the slopes. Hence I could trace the course of the *Leine* up to *Nordheim*, through which it passes in its way from *Göttingen*. At *Nordheim* we crossed this river, and entered a large valley, extending in various branches from the right bank of the stream towards the *Hartz*, and spreading into a small plain behind the ridge of eminences that borders, on this side, the valley of the *Leine*. At a league's distance from *Nordheim* is a great interruption in this ridge, within which

hich the Castle of *Catlenburg* stands on a small ill nearly insulated, in front of the mountains on he northern side. The little river *Söse*, formed y all the streams descending from the *Hartz* on he western side of *St. Andreasberg*, flows at the oot of this mount, and joins the *Leine* at *Nord-heim*. In this intersection of the ridge appear the strata which compose it. Towards the valley, it consists of *strata* of *lime-stone*, like the hills described above on the *Einbeck* side; but towards the *Hartz*, its *strata* are of *sand-stone;* and in the mall plain extending hence to the foot of that hain, a thick superficial soil of *sand* is found to cover sometimes *sand-stone*, sometimes *lime-stone*, while farther on, towards *Osterode*, there is *gypsum*. Of all this I shall have an opportunity of giving deails, which will shew that the country adjacent to he *Hartz* has, in this part, been a scene of the nost extraordinary catastrophes. At half past 7 e arrived at *Catlenburg*.

Sept. 8*th*. I set out on horseback, with the ounger M. Von Pape, and first crossing this inrior plain, which is interspersed with small mounts mposed of various kinds of *strata*, and extends the hole way to the foot of the *Hartz*, we proceeded wards *Grund*, one of the towns belonging to the iners, situated in a valley which follows the chain f the *Hartz*, and stretches towards *Osterode*.

346. After having passed through the villages of *Berke*, *Dorste*, and *Förste*, we arrived at *Bade hausen*. The soil, which here rises, is everywhe cultivated; and though we were now so near th *Hartz*, I did not see any *blocks*. At *Badenhaus* we engaged a guide, who conducted us throug fields to the borders of the valley of *Gru* into which we descended by *Laubhütte*. We w now come to the primordial strata; for both si of this valley present the sections of strata of g *wacke*, wherein are *veins* of *lead galena* contain *silver*. Here has been opened the issue of an a the course of which I had measured by the bar meter at the time of my first visit to the *Hartz* By this *adit*, the pumps of all the neighbour mines were to obtain a level 84 fathom lo than that hitherto employed: I found the work yet completed, though it was carrying on at vario points, by means of shafts, which had been sunk o the line of its intended course.

347. From *Grund*, we crossed the mountain o *Schweinebraken*, farther within the chain of the *Hartz*, in our way to another of the towns belonging to the miners, called *Wildeman*, situated in valley nearly parallel to that of *Grund*, though it slope is in a contrary direction. The small riv *Innerste*, which rises in the valley of *Wildem* flows northward through a succession of vallie till, assuming a more westerly course, it passes b

Hildeshei

ildesheim in its way to the *Leine*; while the waters f the valley of *Grund* fall at *Osterode* into the *ose*, with which they proceed southward to join the me river at *Nordheim*.

348. The same *veins* which are worked at *Clausthal*, the highest part of the *Hartz*, appear also in the lley of *Wildeman*, where there are mines on their rse; they are here smaller and more ramified; as their ramifications lie near each other, they are ked together in the same mines: these veins have nearly the same direction here, as at a greater ele- on; but having been cut through by the *subsidence* ch produced the valley of *Wildeman*, they are nd below the level of the latter, where they have been worked for a long time. Continuing to ow this valley, we came to a place called *Oel- le*, from an oil-mill that formerly stood here; since the mines have been worked at their pre- nt depth, the brook which supplied this mill has en employed for the purpose of setting the pumps motion.

349. In our way back to the valley of *Grund*, we ssed another mountain, of which the side nearest *Oelmühle* is called *Hitschenberg*, and that towards *und*, *Hasenberg*. We had left our horses at *Grund*, ause it is impossible to observe the state of the *ata* in these mountains without passing over them foot. We ascended the *Hitschenberg* by a kind *steps* formed on its slopes by the sections of its

strata of *grey wacke* and *schistus*, which dip rapidly inwards, and thus evidently shew the *angular motions* of these *strata* on the borders of the *subsidence* whence the *valley* resulted.

350. From the part of the mountain on which we arrived, we looked along the whole valley of *Wildeman*, (or wild man;) and it did really present to our view a very wild though at the same time interesting prospect. All the mountains which border it are cloathed with a dark covering of firs; and we could descry no sign of any human habitation, but that here and there the smoke of some heaps of charcoal rose above the trees: it is for the founderies at *Lautenthal* that charcoal is here made. We had below us the small river *Innerste* flowing at the bottom of the valley; and as the latter appeared to terminate in a *cul-de-sac*, we could not easily have judged in what part it afforded an issue to the stream, had not the opening of a lateral valley leading towards *Lautenthal* been indicated to us by a sunbeam which darted on the left through an interval between the firs.

351. We descended this mountain on its opposite side, which is called *Winterberg*; and having first gone down through a very steep wood to a cultivated space, we there followed a path that appeared from a distance to lead to a grotto or simple recess; but on reaching this, we found it to be the head of a *combe* which intersects the mountain, and descends to *Grund*

This part has the name of *Iberg;* there being, in the lower part of the *combe,* a very remarkable obelisk so called, as I have mentioned in my first Travels, Vol. IV. p. 625. It is here that the *strata* of *limestone* which externally border the *Hartz* begin to appear on this side of that chain; and they are seen to rest on *strata* of *schistus* in great disorder. Hence we descended to *Grund;* and it being half-past 7 in the evening before we arrived there, we did not this day proceed any farther.

Sept. 9th. Setting out from *Grund* at 7 in the morning, we took the road towards *Osterode,* along the foot of the mountains, which is either cultivated or covered with woods.

352. We stopped first at *Lasfeld,* with which place I was already well acquainted, it having been here that the late Baron Von Reden had proposed to open an *adit* for all the mines of the *Hartz;* a plan supported by two very strong reasons; first, that the level of this *adit* would have been 400 feet lower than that of the other which was then projected; secondly, that, as it would have been cut across the direction of all the *veins* already known, it might have led to the discovery of others lying between them. In the Philosophical Transactions of 1792, are contained my barometrical observations on the course of these two *adits,* which, with respect to the heights, had a singular agreement with the levels taken by the geometricians of the *Hartz.* But the length of the *adit*

proposed by Baron Von Reden would have been so great, and so much time would have been employed in making it, that it was not undertaken, on account of the expense.

353. Proceeding through the *valley* towards *Osterode*, we soon came to the part where its eastern side, being the foot of the mountains, consists of *schistus*, while the western is that of some hills composed of *gypsum*; a subsidiary proof, of which many examples have appeared in the course of my Travels, that *vallies* have not been excavated by *running waters*; I call it a subsidiary proof, because, when *vallies* are attentively observed, every thing in them is seen to concur in demonstrating that they have originated in *fractures*, *subsidences*, and *angular motions* of the *strata*, which have been frequently attended with changes in the species of the latter at the same level, occasioned by the irregularity of their *subsidence* in spaces of small extent.

354. We went on the whole way to *Osterode* through the same *valley*, chiefly on account of a great work which had been undertaken there; that of making a road on the slope of the hills of *gypsum*, on this side very steep; I therefore hoped to obtain a view of the *strata*, which I had not been able to observe in my first Travels, because this slope was covered with a loose soil. Though much labour had been employed here, the road was not yet nearly completed; it was however in a passable state, so

that it afforded me the opportunity of making such observations as I wished. The sections of the *stony strata*, which had been concealed by the loose soil, were now laid open; and while, in the steep parts fronting towards the *Söse*, I had seen nothing, up to the top, but *strata* of *gypsum*, I perceived, on the side next to *Osterode*, that above these *strata* lay others of a *lime-stone* mixed with sand, in which were *chamæ* of a considerable size; these *strata* dipped into the interior part of the hill, and presented their section at the top. On the hill itself, the summits of the *stony strata* were covered with *strata* of *marl and sand;* and in these, as I was told, had been found the *rhinoceros's bones* which, in my first visit to this country, I had seen in the cabinet of Professor Hollman at *Göttingen*.

355. At some distance from *Osterode*, the *gypsum* forms the surface of these hills; and I saw here a phænomenon which I had observed, at a much higher evel, in the valley affording a passage across *Mont Cenis*, where the soil consists likewise of *gypsum;* namely, large *tunnels* which receive all the rain-waters and melted snows of the surface. These singular cavities have probably originated in fissures passing through all the *strata*, even the lowest; and he waters, running into those apertures from every ide, have gradually dissolved the *gypsum*, the surace of which shews signs of erosion. To a similar ause are also to be ascribed the *tunnels* that I have escribed in various parts of the mountains of *Neufchatel;*

chatel; where the *loose soil* has in the same manne been carried away by the waters running into crevice in the *stony strata* which lie beneath it. On the hil of *Osterode*, these tunnels are not very dangerous i winter, because, though they are sometimes filled b the winds with drifted snow, it does not remain i them long without being melted, and the road is wel marked out, and very firm. But the case is ver different on *Mont Cenis*, where the chief danger o the passage in winter, during tempestuous weather arises from these tunnels. When fresh snow has fallen on that mountain, the men and the mules, proceeding always in the same tracks, press it down, and soon form a hard road, which is like a causeway in a marsh, and on the sides of which the untrodden snow remaining loose, is constantly levelled by the winds, till the long continuance of the hard frosts reduces it to powder; but, when very high winds prevail, they raise and drift it, and thus obliterate the traces made by the travellers. Crosses are indeed erected, at certain distances, to mark out the road; but when the air is obscured by clouds of this pulverized snow, it is impossible, at the distance of only two or three paces, to distinguish any object: if a passenger happens then to miss the indurated causeway, he falls into the loose snow, without being able to judge which way he ought to attempt wading through it in order to recover the road; and should he unfortunately step into one of these *tunnels*, he must inevitably perish. Those, therefore, who have occasion to pass over *Mont Cenis* in winter, always form a caravan, that, in case of accidents, they may afford assistance to each other: the guides, indeed, who accompany travellers, and supply them with mules, refuse to undertake this passage when they see from below what they call *la tourmente;* that is to say, clouds of pulverized snow borne about on the mountain by the winds. Yet in summer nothing can be more cheerful than the aspect of this high Alpine valley; for its whole soil is covered with a fine verdure, embellished with flowers, and especially with beautiful bushes of the *rhododendron.*

356. After we had passed over the hills of *gypsum,* beginning at *Osterode,* we re-entered, at *Dorste,* into the same road by which, the day before, we had proceeded to *Grund;* now in the whole of this excursion along the foot of the *Hartz,* we had not found a single *block* of *granite.* We observed in the soil fragments of several other stones, and among the rest, of the *kiesel-schiefer,* or *pebble schistus,* which is the *touch-stone;* it is black, strikes fire with steel, and is very brilliant in its conchoidal fracture. This stone is not found in any part of the *Hartz* except *St. Andreasberg,* where it is met with in kidney-shaped masses, or in veins running through the *schistus* of the mountain: it is only by the catastrophes of the *strata* that fragments of it can have been scattered on the exterior side of this chain, where, with other broken masses of various kinds, they are contained in the loose soil, above the level of every stream which could have propelled them.

On the bed of a brook that falls into the *Söse*, we saw some rounded fragments of the *kiesel-schiefer*, which had belonged to the loose soil, and which, in consequence of the trituration of their surface, were already in a state to be used as *touch-stones.* At half past 7 in the evening we arrived at *Catlenburg*, where I spent two days with my friends; and after passing another at *Göttingen*, we returned to *Hanover* on the 13th.

RNEY *to some* COAL-PITS *in the District of* AUENSTEIN, *and afterwards to the Banks of* e WESER, *near* HAMELN.

PATJE, a member of the council at ***Hanover***,
whom I had had the pleasure of becoming ac-
nted in *England*, where we had travelled toge-
proposed to me an excursion for the purpose
bservation, to which I very willingly agreed.

pt. 23*d.* 1797.—We set out from *Hanover*, at
the morning, by the *Göttingen* road, which we
ed near *Elze*, and turning westward, proceeded
rds *Wittenburg*, situated on the southern extre-
of a hill; this hill is covered above with an oak
l; but its lower part is cultivated on a soil min-
with *lime-stone* rubbish, which, though of little
h, is very fertile; for the *strata* under it have
section near the surface, and dip in great dis-
r into the interior part of the hill, so that the
of plants can easily penetrate between them.
is an advantage which our continents derive, in
many

many places, from the catastrophes of our *strata* previous to their birth; and in this part of the country, the same phenomenon may be every where observed.

357. We descended the hill of *Wittenburg* on its western side, and turning a little to the south, proceeded to *Benstorf;* hence resuming our course westward, we arrived at *Osterwald,* the place where the beds of *coal* were worked, and where there was a glass-house in which very beautiful glass was made. M. Bauer, director both of the *coal-pits* and of the glass-house, having learnt from M. Patje of what nature were the observations which I wished to make, afforded me his assistance in a very obliging and intelligent manner. He first shewed me a collection of small stones found in the gravel of the neighbouring soils, which he had caused to be cut into a size and form proper for seals; they had taken the finest polish, and were capable of receiving the most delicate engravings; I saw among them a great variety of beautiful *granites* and *porphyries,* red and yellow *jaspers, hæmatites,* and *touch-stones.* The first of these stones belong to *primordial strata,* in which the others are only adventitious; yet here they are scattered over the surface of a country, where there are no *strata* but of *lime-stone* and *sand-stone!* However, since these, as I shall continue to shew, have themselves undergone the most violent catastrophes, it is not surprizing that fragments of the *inferior strata* are found on their surface.

358. We were now in the bailiwick of *Lauenstein*, a country interspersed with hills, which, when seen from higher ground, resemble so many *islands;* for they all stand separate from each other, most of them having a lengthened form, and being covered with wood: it will soon appear that they are only the ruins of *strata*, being such masses as remained at a higher level than the rest, during the general subsidence. The intervals of these hills are in part cultivated; but in the space between *Benstorf* and *Osterwald* cultivation would be impracticable; this space, though a plain, has continued a forest, because the soil, every where very rugged, is scattered with *blocks* of hard *sand-stone*, some of which I observed to be nearly 10 feet square.

359. I supposed the word *Osterwald* to signify *eastern forest;* but the tradition of the country derives it from *Oster*, one of the deities of the ancient Germans. The hill which rises here is cut off almost abruptly on its western side, where the sections of its various strata are found beneath slopes composed of rubbish. It is in this part that the beds of *coal* have been discovered, their sections appearing between those of the stony strata. M. Bauer ascended the hill with me, in order to explain to me all particulars relating to it. The summit above the steep side is covered with immense *blocks* of a *sand-stone*, very similar to that which I have described at *Rehburg*. Below these *blocks* is seen the section of *strata* of the same stone: but all the rest of this side

is in the greatest disorder, occasioned by the ruptures and falls of large masses. From these exterior characters alone, it cannot be doubted that the *strata* have here suffered fractures by the *subsidence* of very large masses in the spaces now vacant; but this is again a hill of which the interior state is discovered by the beds of *coal;* and I shall now detail the information that I received on this subject from M. Bauer.

360. All the *strata* incline strongly towards the side opposite to the abrupt part, but without any regularity, because of their fractures. Their order, which is as follows, is the same in all their different masses. Under the *strata* of hard *sand-stone,* is found a brownish fissile stone, covering the uppermost of the *beds* of *coal,* which is not worked, because it is not sufficiently *mineralized;* being in great part merely a blackish powder. Below this, *sand-stone* is again found, but of a kind less hard than that of the higher strata. Next follow again *strata* of the foliated brown stone, which cover a bed of very good *coal,* about two feet in thickness, separated from another below it by *strata* of *lime-stone.* M. Bauer shewed me some rocks of the latter *strata* projecting on the slope; and going down to them, I found them to contain some *turbines,* some little *mytili,* and other small *marine bodies.* Lastly, beneath the third bed of *coal,* are *strata* of a very hard *marble,* of which likewise some rocks were pointed out to me by M. Bauer; and in these I perceived

small *ostreæ*. Thus then is found every where the same proof that the *peat*, of which *coal* is the result, was mineralized beneath the waters of the sea. Three successive *subsidences* must have here taken place in the same *island*, and, in the intermediate periods, fresh *peat* was formed on its surface; but, when the latest subsidence occurred, the sea had lost its mineralizing faculty; in consequence of which the *peat* continued a blackish powder imperfectly indurated.

361. I said above, that the same order of *strata* was preserved in all the masses which compose the hill, but that they had undergone many ruptures. These beds of coal have been followed a long time, as well lengthwise in the hill, as across it, but they are very much broken; and beyond every fracture, they are found to have changed, not their *level* alone, but their *inclination*, and sometimes even their *direction*. This internal disorder appears very little in the exterior form of the hill, because its ruinous state has been much obliterated by later operations of the sea. M. Bauer, though not a geologist, had formed the same judgment respecting this situation of the *strata*, as must necessarily be formed by every reflecting man; he not only believed that they had all been broken, and had partially subsided, but he entertained no doubt that the mass, which had disappeared in the vacant space in front of the steep side, had sunk, and that, by digging there to the proper depth, the beds of *coal* would again be found.

362. From M. Bauer's windows, I had a view of a large amphitheatre of high hills, covered with wood, which is called the forest of *Ballinge.* When seen from this point, these hills appeared to be continuous; but in the plan of the Engineers, which was shewn to me, they resembled the tentacula of a polypus, branching out from a deformed body. The case is the same with most groups of hills: nor can this have proceeded from any other cause than the catastrophes of the *strata;* proofs of which are offered, not only by the state of the interior part of the hill of *Osterwald,* laid open by men in pursuit of their own advantage, but by the impossibility that the intervals between all these hills can have been excavated by the running waters, which here form only rivulets, and flow in meadows. In the area of this large amphitheatre, there are some smaller hills, evidently nothing but masses of *strata*, left at a higher level than the rest during the *subsidence* by which this area was formed. My attention was particularly attracted by one of these small hills; for it was not covered with wood like the rest, but on its surface rose a prodigious number of small pyramidal projections, bearing some resemblance to the quills of a porcupine. I made inquiries of M. Bauer respecting the nature of these projections; he told me that the hill consisted of *lime-stone strata,* dipping rapidly on the farther side, and split at the top into a multitude of laminæ, the points of which, rising above their own rubbish, produced this singular appearance.

363. Thus we find in this country also very characteristic marks of the catastrophes of the *strata*; by which districts of a similar nature have everywhere been dissected into *hills* and *vallies;* for that these *strata*, must have been originally continuous and nearly horizontal is evidently shewn by the *marine bodies* contained in them. After M. Bauer, by these interesting details, had made me acquainted, in so short a time, with circumstances, respecting which it would otherwise have taken me long to obtain information, we set out from *Osterwalde* for *Lauenstein*, situated at the foot of an opposite hill; and M. Tare, the Amtmann of this place, was so good as to give us a lodging at his house.

Sept. 24*th.* We set out from *Lauenstein* at 7 in the morning, in order to cross the country towards the *Weser*. For a long time, we travelled over sections of *calcareous strata*, which descended inwards, inclining the same way that we advanced; we could see them very distinctly in the road, because the dust produced by the wheels of the carriages had been washed away by frequent showers. As the chain, over the foot of which we were travelling, is covered with wood, its more distant parts, when viewed in perspective, appear to be continuous; but, as we approached it, we saw it separate into distinct hills. Along the road, and in the bordering woods, there were quantities of large *blocks*, and smaller fragments, of the same *sand-stone* as those which I had seen scattered on the summit of the hill of *Osterwalde;* and here and there projecting rocks of this stone appeared in the woods, though as I have said, we were travelling on a road formed by the sections of *strata* of *lime-stone.* Near the end of the chain, I observed that the scattered blocks consisted of *lime-stone:* beyond this, I saw only low hills, much intersected; and in the part where the country thus opens, a mount projects, on which stands the castle of *Coppenbrugge.*

364. When we had issued forth into this open space, I saw on a sudden, in a part where the road turns towards the *Weser*, a great many *blocks* of *granite*, one of which was very large; and the sand was here mixed with gravel of many other kinds of *primordial stones, porphyry, semi-transparent quartz* and *touch-stone.* From hence, however to *Hameln*, the scattered blocks, both on the ground, and by the road-side, were sometimes of *lime-stone,* sometimes of *sand-stone;* only here and there I still saw some *blocks* of *granite.*

365. After a short stay at *Hameln*, we crossed the *Weser*, and ascended its course on the left bank for about a league, by a road which at first was cut in the slope of rubbish forming the foot of the hill called *Klutz;* and the *strata* of this hill being here laid open, it appeared very evidently to have been left in its present form by the subsidence

which produced the valley of the *Weser:* These *strata* alternately consist of *sand-stone* and of *marl.*

366. At the extremity of the hill of *Klutz,* we passed in front of the opening of a valley which leads to *Pyrmont;* the opposite side of this valley was formed by a hill called *Ohrberg,* composed of the same strata as that of *Klutz;* but while the latter presents a steep side to the entrance of the valley, that of *Ohrberg* slopes down to it from a distance, and is precipitous on the opposite side, on which lies the village of *Ohr,* forming a part of the estate of M. VON HACK, to whose house we went, and there met with a very obliging reception. This gentleman led us up the steep side of the hill, by a path which he had caused to be cut in order to facilitate the ascent: this path was winding, and in some places steps had been formed in projecting parts of the stony strata. On the summit was a wood, in which alleys had been opened in various directions, towards such parts of the brow of the hill as commanded the finest prospects. On the side next *Pyrmont,* there was a view up the large valley leading towards that place, but obstructed by a mountain over which the road thither is carried. On the side next the *Weser,* we had below us a point, where the river, directly attacking and excavating its bank, has occasioned it to crumble down; as will continue to be the case, till the course of the stream shall have assumed a wider

bend. The right bank of the *Weser* is here a plain, beyond which rise the hills of *Lauenstein*. Now after observing this part of the country, and viewing the state of the *strata* in the hills, as well as the quantity of *blocks* everywhere disseminated, it cannot be doubted that the whole of the low space between the *Ohrberg* and the hills of *Lauenstein* is a *subsidence* of the *strata*, different masses of which have here and there remained, forming small *hills*, some of *lime-stone*, and others of *sand-stone*, above the general level. We returned in the evening to *Hameln*.

Sept. *25th.* We set out from that place for *Hanover*. Though we did not take exactly the same road along which I had travelled with Baron Von Reden, passing through *Hastenbeck*, I again saw by the way-side, whither they had been brought when taken out of the fields, abundance of the blocks of *hard sand-stone*, which I described in that journey, intermixed with some of *granite*.

367. There being no eminences but those of the chain of the *Hartz*, which the geologists who suppose the *transportation* of *blocks* by running waters can possibly assign as the source of the vast quantity of *blocks* of *granite* and other primordial stones

scattered over *Lower Saxony* and *Westphalia*, as far as the coast of the *North Sea;* and Mr. Playfair, in particular, having given as a proof of that hypothesis what, were it true, would really be the case, that the *quantity* of these masses is always *proportional* to their proximity to the *mountains* from which they have proceeded; I had resolved to submit this criterion to the test of observation.

368. Such was the motive which had determined me in the choice of my road, when, in August, 1786, I had travelled with Baron Von Reden to *Clausthal*, situated in the centre of the *Hartz*, near the great granitic summits. This road, of which I have already given a description beginning § 166, lay through the valley of *Esbeck*, on the southern side of the chain; and it has been seen, not only that, in approaching the latter, I found no augmentation in the quantity of the *blocks* of *primordial stones*, but even that they totally vanished, and that, in their stead, I observed others of a *hard lime-stone*, no *strata* of which externally appear. It was with the same view that, in September 1797, I had travelled with the Counseller Von Pape towards the eastern part of the foot of the *Hartz*, described § § 346 et seq. Here again it has been seen that there are no *blocks* of *primordial stones* in the large *valley* which opens at *Nordheim*, and forms an interruption in the chain, extending from *Hanover* to *Göttingen*, composed of *strata* of *lime-stone* and *sand-stone;* although this *valley* branches off in

every direction, towards the eminences which consist of *primordial strata.* It remained for me to obobserve another very interesting part of the vicinity of the *Hartz*, that on the north east; where open three *vallies* descending directly from the great *granitic* summits, of which the highest, as I said before, is the *Blocksberg;* at the entrances of these three vallies are situated the three towns of *Blankenburg*, *Wernigerode*, and *Ilsenburg.* I was prevented, by various circumstances, from undertaking this journey, till very late in the season; in consequence of which I was obliged to shorten it, being stopped by the snow: however, I went far enough to satisfy myself with respect to my principal object.

JOURNEY *from* BRUNSWICK, *through* HELMSTEDT *and* HALBERSTADT, *to* BLANKENBURG, WERNIGERODE, *and* ILSENBURG *at the foot of the* HARTZ; *with the return through* WOLFENBUTTEL.

DEC. 3*rd.* 1797. At 8 in the morning, I set out from *Brunswick* for *Helmstedt*, at the distance of 5 German miles. The first part of this road, by *Destedt* and *Bornum* towards *Königslutter*, lay through a country which much resembles that of *Calenberg*, between *Hanover* and *Göttingen;* for it consists of hills very well cultivated, with a *sandy* soil, in some places of great depth, but more fertile than that of the heaths. In many parts, the *stony strata* lie very near the surface, and even rise above it in rocks: I saw by the way-side, some quarries of a *lime-stone* which contained many *marine bodies*, and of which the larger masses were used for building, and the smaller for mending the road; but there were certainly in the neighbourhood quarries of *sand stone* also; for I saw some houses faced with it. As far as *Bornum*, the *blocks* bordering the causeway were of *granite* and other stones of that class; yet beyond this, and consequently nearer to the *Hartz*, these *blocks* disappeared, and for some way I saw only some *blocks* of *lime-stone;* afterwards succeeded those *blocks* which, as the irregularity of their figures had formerly led me to mistake them for *concretions* formed in the *sand*, had then called *grès;* but I have had frequentl occasion to repeat, that, since I have seen so man of them on different soils in *Germany*, an on hills of *chalk* in *England*, I have been convince that they are fragments of *strata* belonging to th class of *granulated quartz*, nearly approaching the *hard sand-stone;* and that the irregularity their form is to be ascribed to the unequal corrosion of their surface by atmospherical actions. Many large masses had been broken to make the stone-posts along the side of the causeway; and in these I could plainly distinguish regular *strata.*

369. From *Königslutter*, I crossed a hill in the way to *Helmstedt;* and along this road, I saw, in some places, a great many *blocks* of *granite* mingled with those which I have just mentioned. At half past 3 I arrived at *Helmstedt*, where M. Von Crell, the celebrated author of the *Annals of Chemistry*, published in *Germany*, with whom, while at *Brunswick*, I had had the good fortune to become intimately acquainted, was so kind as to offer me his assistance in the observations which it was my intention to make in the neighbourhood of this town.

Dec. 4*th*. M. Von Crell first led me to the top of an eminence out of the town, where there are three large heaps of *blocks* of *granulated quartz*, supposed to be mausolea in honour of some of the chiefs of the ancient inhabitants of the country. The soil of this hill consists of sand, and gravel of various beautiful *primordial stones*, every where mixed with *flints*. I saw scattered on it some of the *blocks*, the forms of which were very remarkable; one, in particular, by the side of the road, struck me so much, that I could not help stopping to admire it: but that it was deficient in myological exactness, it might have been taken for the trunk of an ancient statue of HERCULES, so strongly were the muscles marked, and so natural was their swell. This block might have been worthy of a distinguished place in a statuary's workshop, where those who had seen it would have been not a little puzzled by it. We were here opposite to a large hill, which had a wood on its upper part, and of which the whole slope was so much overspread with the same *blocks*, that it could only serve for pasturage: I was told that the soil of the wood also was completely covered with these *blocks* between the trees.

370. After *this*, M. Von Creli conducted me to another hill, which rises near the ramparts of the town, and in which, for some years, had been worked a bed of *vegetable substances*, like those already described in *Mount Meisner* and its vicinity, in the country of *Hesse*. This bed had first been disco-

vered and attacked from a section which presented itself in a neighbouring valley; but the work being here interrupted by the continual crumbling down of the soil, a student of this university, who had observed similar beds in other countries, had three years since obtained, and still enjoyed, the privilege of working it by shafts. I went down by one of these to the place where the work was at present carried on, in order to discourse with the miners and to observe the bed, which is about 15 feet in thickness; it rests on aluminous clay, and is covered with common clay, and with a great depth of sand. The lower part of this bed has nearly the consistence of *coal;* its substance breaks like other hard bodies, but is not smooth in the fracture. The rest of the mass is absolutely nothing but *peat,* reduced to a brown powder, in which, towards the bottom, are found trunks, branches, and roots of trees. The inclination of this bed, and of all the *strata* that accompany it, is about one foot in seven, towards the side which is farthest from the town: its section is again found on the slope of the hill nearest to the town; and there also it was discovered in digging out sand. Neither the inclination nor the direction of the bed has any relation to the exterior form of this eminence, which belongs to a space consisting of small hills, encompassed with others of greater height. The gentleman who had undertaken this work believed, from his own observation, that the *bed* was of great extent; but that, as the part which was at present worked continued to descend deeper and deeper, there was no chance of following it far, unless it could be met with at a higher level in some other eminence.

Dec. 5th. I remained this day at *Helmstedt*, and t was very fully occupied; for I spent the whole of t at the house of M. BEIREIS, a Professor of the University, who had formed an immense collection, omprizing a great variety of objects; which excited ery general surprize, because he was known to have possessed no fortune at the time when he began it.

371. I found M. Beireis a man of very general knowledge, and in particular deeply conversant with the great operations of chemistry, on which I took nuch pleasure in hearing him discourse, so far as I ould induce him to proceed. But those who, in eir pursuit of this science, have been led to the scovery of processes whence great advantages may derived, are naturally disposed to secresy respect-g them. M. Beireis admitted that he possessed any such secrets; and it will be evident, in the equel, that this must necessarily have been the case. Nothing was known on the subject, except that he had found out a method of making *carmine*, which he sent for sale to most parts of Europe, it being superior to every other kind, as well in the brilliancy as in the permanence of its colour; and several per-sons at *Helmstedt* were persuaded that this alone was sufficient to account for the large revenue which t was clear he must enjoy.

372. The use which this extraordinary man made of his fortune was much to his honour. Not being married, he had nobody living with him in a large house, filled from top to bottom with his various collections, except an old female servant; but he had placed all his relations in a state of affluence. He was Professor of Physic in the University; he also practised as a physician; and every day, at a particular hour, he received sick persons gratis, supplying those who were indigent with medicines, and even with money; and indeed his beneficence was general. I was really astonished at the sight of his different collections. That of minerals, in the first place, was one of the richest which I had ever seen; for he had commissioned persons throughout a great part of Europe, to give him information of all the most remarkable specimens which were known to exist, or which appeared in the cabinets of other collectors; and whenever he heard of any objects that were not already in his possession, he spared no price to obtain them. In his anatomical collection, I saw, among other things, the different microscopes and all the microscopic preparations of LAMKENS, a celebrated anatomist of *Berlin*, from whose family he had purchased them: if my time would have permitted me, I should gladly have devoted a whole day to this single class of objects, in which the organs of the most interior of the animal functions were plainly shewn by the injections made even in parts of such minuteness as, in their natural state, to be almost imperceptible. As the attention

of M. Beireis had also been attracted by the progress of the arts, he had obtained from the descendants of OTTO GERRICK, one of the first among naturalists who had employed himself in experimental philosophy, all the physical instruments described and engraven in his work. He possessed likewise the famous *automata* of VAUCANSON, which I had formerly seen at *Geneva*, and which had excited general admiration in all the countries where they had been exhibited. Lastly, that I may not occupy myself too long with details relative to this surprizing collection, M. Bereis had procured, at a great expense, *two* pictures by each of the great Italian and Flemish painters, whose progress in his profession was thus distinctly shewn; for the first of these pictures was chosen from among the earliest works of the artist, and the other was one of the last which he had painted, according to the dates placed on them by the painter himself. In short, such was the merit of the collector, and so vast the variety of the objects collected, that I never passed a more interesting day in the cabinet of any private person.

Dec. 6th. I set out from *Helmstedt* for *Halberstadt* at 10 in the morning; the distance between these two places was only four of the miles of the country, but I was told that, on account of the badness of the roads, it would be as much as I should be able to travel in the course of the day; and it even happened that an accident prevented me from reaching *Halberstadt* that night.

373. I was here in the most direct road by which the *blocks* of *granite* now scattered over the surrounding lands can be supposed to have migrated from the *Hartz*. For the *Blocksberg*, the highes of the *granitic* mountains of the *Hartz*, and the others which encompass it, are not far from the borders of the chain on this side; and the three vallies mentioned § 368, together with the waters flowing in them, proceed directly from these mountains, and open into the low grounds. This therefore is a very important road, with respect to the hypothesis of the *migration* of the *blocks;* and my description of it will shew whether it affords the slightest grounds for this hypothesis.

374. For some way after I had quitted *Helmstedt*, I saw blocks of *granulated quartz* and *hard sand-stone*, mixed with some of *granite;* farther on, I perceived only the latter, but in small numbers; and they totally disappeared near a village called *Batenberg*, which is at a league's distance from *Hammersleben*, where is the half-way house. I must here again mention a proof that the period is not very remote at which the lands in *Lower Germany* were first taken into cultivation. On inspecting the map a vast many places in this district will be seen t terminate in *leben;* in other districts, *rode* is t

prevaili

prevailing termination, and in others, *reuth*; now all these are words which, in the dialects of the country, are indicative of places newly brought into tillage. As far as *Batenberg*, the land was well cultivated on a *sand* mixed with *gravel* of various kinds, amongst which I everywhere saw *flints*; but this *gravel* was only superficial; for in parts where the road was deeply cut, I observed regular *strata* of pure *sand* under that in which the gravel was contained. *Batenberg* is in a low situation; and beyond it I remarked a great change in the soil, where instead of *blocks*, I now saw only fragments of thin *strata* of *lime-stone*, great quantities of which had been taken out of the land when it was cleared for cultivation, and laid up in heaps by the road-side; there were even large spaces which it had been impossible to convert to any use, on account of the abundance of these fragments. I afterwards crossed a cultivated hill, whence I saw at a distance some large heaps of them; this, probably, was the spot to which the name of *Hammersleben* had originally been given.

375. According to the usual custom, the postillion stopped a long time at this half-way house, where I imagine he had too much liquor; which had nearly led to fatal consequences. The shades of night were anticipated by clouds descending on he hills, with storms of snow; so that the postillion ost the road, and drove to the edge of a precipice, down which we must have fallen, if the horses had

not stopt suddenly of their own accord. Fortunately the clouds, at that moment, opened, and the moon, breaking out, at once discovered to us our danger, and enabled us to avoid it; for we saw before us a hollow road, which the postillion had missed; but we had considerable difficulty in finding our way down to it. I walked by the carriage, and supported it, on the side where it was likely to turn over, and the postillion placed himself at the head of his horses, in order to hold them up by their bridles; in this manner we descended a very rapid slope; and having thus reached the road without any accident, it brought us under the precipice which we had so narrowly escaped, and which proved to be the side of a large quarry of *lime-stone*, worked for the purposes of building and of making *lime*. In this spot there was a village, where I was glad to hear that I was now only half a league from *Halberstadt*; but the night being very dark, my postillion again lost his way; so that, while I was expecting every moment to reach that town, I was really travelling to a greater distance from it: at last, I arrived at the village of *Wegeleben*, which I found was two leagues to the east of *Halberstadt*, and at which, as it was now nine o'clock, I was obliged to spend the night.

Dec. 7th. I set out at half past seven in the morning from *Wegeleben* for *Halberstadt*, where I did not arrive till half past ten, because the weather was now become extremely bad, the wind being very high,

gh, with frequent storms of snow and sleet; which
ad an unfavourable appearance for my intended
cursion in the *Hartz*.

376. The soil, here all in tillage, was in some
laces mixed with *gravel* of every different spe-
ies, and in others, with fragments of *lime-stone.*
had now reached the borders of the *Hartz;* and
stead of the hills of loose *sand*, over which I had
avelled from *Helmstedt*, I found hills composed of
rata of *sand-stone*, which appeared like rocks heaped
ne on another. Near the town of *Halberstadt*, is
e *Spiegelberg*, a small chain of this kind, presenting
n every side abrupt faces in the greatest disorder.

377. I set out from *Halberstadt* at half past 11
r *Blankenburg*, a small town at the foot of the
artz, on the N. E. of the *Blocksberg*. I first
rossed the small chain of the *Spiegelberg*, from
e summit of which I saw nothing, as far as the
ot of the *Hartz*, but small insulated hills com-
osed of *strata* of *sand-stone*, dispersed in the most
aotic disorder over a cultivated sandy soil. Many
f these mounts appear as if intersected with walls,
ese being formed by the edges of the *strata*, which
ave their sections at the summit; in others, the
trata rise pyramidally, without any regular order,
ut only at the top, the slopes of these mounts being
overed with rubbish.

378. We have now nearly reached the foot of the only *granitic eminences* which can be considered as belonging to those vast tracts of land, already described on the west and on the north of the *Hartz*, and strewn with *blocks* of *granite* in such astonishing abundance: on this border of the chain are the openings of the three *vallies* which I have mentioned as descending directly from these *eminences*; if therefore this had been the source of the *blocks* scattered at so great a distance, it is here that the greatest quantities of them should be found; yet I observed very few in comparison with the prodigious numbers which I had seen accumulated in many parts of that extensive space. But this is not the only circumstance to be considered. I have had repeated occasions to remark, that, in order to judge whether the stones scattered around mountains proceed from the mountains themselves, it is not sufficient to attend to the *genera* of the former; their *species* also must be examined. For example; if the *blocks* of *granite* which lie at the opening of the *vallies* descending from the region of the *Blocksberg* had really proceeded thence, they would naturally be of the same *species* of *granite* with that mountain. Yet among these *blocks*, I found masses of a *granite* containing *schorls*; which I never observed in any of the *granitic strata* of the *Hartz*.

379. At half past two I arrived at *Blankenburg*, where I went immediately to call on the Counsellor

VON

HUNGER, to whom I had been recommended M. Von Crell, on account of his perfect acintance with these mountains, and of a collec- which he had made of their stones and minerals. ould not indeed have consulted anybody more able of giving me information with respect to relation subsisting between the *stones* scattered und this part of the *Hartz*, and those belonging he mass of the mountains themselves; it was efore on this subject that I first discoursed with : he was well acquainted with the masses of *nite* containing *schorls*, which I had remarked he neighbourhood of *Blankenburg;* and he not confirmed me in the belief that there was no *nite* of the same species in the eminences of the *tz*, but he told me that this dissimilarity exled to many other kinds of stones; and for exle, that there were found here scattered masses aining *garnets*, of which, in the *Hartz*, there no appearance.

80. Our conversation turning afterwards on r objects, M. Von Hunger gave me a small e of the *sand-stone* of the neighbouring hills, on h was the impression of a *leaf*, apparently being to an *oak;* and he added that, in this dis-, there were indications of *coal*, but that it was known to lie anywhere so near the surface, as fford a hope of deriving advantage from it. He me also some pieces of a *stratum* very rich in the compact parts containing that ore in the

proportion of 60 lb to 114 lb: some parts however have been rendered very porous by *marine bodies*, of which there were originally many in this stratum, though they are now destroyed. The specimens given to me by M. Von Hunger had contained abundance of fragments of *entrochi* both angular and round; those bodies themselves had perished; but visible impressions of them remained in the vacancies which they once had occupied; and in the centre of each of these vacancies was a small column of ferruginous quartz, which had been moulded within the axis of the *entrochus*. I have called this a *stratum*, and not a *vein*; for it rests on *strata* of a fine *marble* spotted with *red*, and is covered with others of a *grey marble*; it is situated in the interior part of the chain, at the distance of three leagues from *Blankenburg*, on the side next *Elbingerode*, a place which I had visited in my first Travels. Here then are *strata*, certainly formed at first in a nearly *horizontal* situation at the bottom of the sea, since *marine bodies* are contained in them; yet now they are *vertical*, as is likewise the case, more or less, with the *schistose strata*, which follow them farther inwards in the chain; and hence there remains no possibility of doubting that the *vallies* here have been produced by the *fractures*, *subsidences*, and *angular motions*, of the *strata*; which will be still more evidently proved by the phenomena of these *vallies* themselves.

381. My wish to approach the *Hartz* on this new side had not been the only motive of my journey: I

had meant, from *Blankenburg,* to visit the *Bau-*
mshöle; a cavern which, like that of *Scharzfeld,*
scribed in my first Travels, is celebrated for its
at extent, the beauty of its stalactites, and the
es found on its bottom; besides, in the way to-
rds this cavern, I was to pass near the *Rosse-trap,*
yramid of *granite,* which rises from the bottom
a *valley* where the sides consist of *wacke;* but all
hollow parts of the road being filled up with the
ow that had lately fallen and had been drifted by
igh wind, I was told at first that it was impossible
advance so far among the mountains, as to reach
her of the objects which I had in view. This was
opinion of several men who had assembled round
inn, and whose occupation was to cut wood or
w stone in these mountains; nor would any one
ong them undertake to be my guide. However,
vards the evening, a man who had heard me talk-
with them desired to speak to me; he told me
t it was really impossible to go to the *Bauman-*
ile, but that, if I was not afraid of wading through
snow, and sometimes falling into it, he would
nture the next day to conduct me to the *Rosse-*
p, provided the weather did not prove too severe.
regretted the *Baumanshöle;* however I had pro-
ted to make a journey, at some future period, to
caverns of the country of *Bayreuth,* which are
ually famous as containing bones; and I was
refore glad to accept this man's proposal;

Dec. 8*th*. There was a high wind in the morning, with much snow, and my intended guide came to inquire what I meant to do; I asked him whether he thought the weather was likely to hinder us from effecting our purpose; he answered that he did not believe it would, only we should now find the snow a little deeper: on this, I determined to make the attempt.

382. We set out at half past eight in the morning, and first crossed a ridge of hills called the *Heidelberg*, by one of the eminences of which, whereon stands the castle of *Blankenburg*, the passage up the vallies to the mountains is closed. Beyond this, we descended into a large vale consisting of meadows, now covered with snow; and crossing it obliquely, we arrived, at half past nine, at the foot of a woody mountain. This was the place where my guide had expected to find the snow of the greatest depth, because, when drifted by the wind, it accumulates among the trees: he had, in fact, great difficulty in finding any path, and we repeatedly sunk into cavities filled with snow; however, at last we gained the upper part of the woods, and the foot of the rocks along which we were to proceed to the *Rossetrap*. On reaching that spot at half past 10, we found ourselves suddenly on the brink of a very deep precipice, forming one side of a most remarkable fracture in *strata* of a reddish brown *wacke*; at the bottom of the precipice, this fracture widens

into

o an amphitheatre, which rises up to the summit the mountain.

383. Though the side of the fracture on which we ived is abrupt, it is studded with many projecting ks; but the opposite side, of much greater height, es from the bottom like a wall, extremely shat- ed, the *strata* having been cut across their planes, d presenting their sections, which are nearly *ver- al.* The *Bode*, a small stream descending from region of the *Blocksberg*, after many windings in her vallies, enters the amphitheatre by the upper t of this fracture. I would gladly have had with one of those who suppose *streams* to have cut *vallies* in which they flow, that I might have di- ted his attention to the circumstances which I shall describe. In the part where this great cleft ins, nothing is to be seen but an absolute chaos rocks; and from the spot where I stood, I could discern the little river, above the point at which alls in a cascade, from the lower part of the am- theatre down to the bottom of the valley. As I rnt from my guide, the road from *Blankenburg* to *Blocksberg*, passing over the high ground whence *Bode* descends, follows the meanders of this am through the small vallies which lie between se rocks: he pointed out to me above, the spot re the stream enters this chaotic part of its rse; and he made me remark an irregular line rocks, between which it falls in several small cades: in the intermediate spaces, where it flows

calmly, the road lies on its border, but has been cut in the rocks, where the stream is more rapid, and its channel more confined. From this spot, also, I saw enough of the situation of the *strata* in the summits of the projecting rocks, to judge it to be only by subsidences, successively more and more considerable, of the broken masses of the *strata*, that the whole of the amphitheatre could have been produced.

384. Another proof here presents itself that this large cleft is entirely the effect of the catastrophes which have been undergone by the whole mass of the *strata*, down to the very lowest. I have mentioned that the opposite side of the narrow valley, which is much the highest, is formed by the section of *strata* of *wacke* of a reddish brown. Now though the slope covered with wood that we had ascended in our way hither is composed of large fragments, above which rise several rocks of the same *wacke*, with *strata* dipping inwards, yet this side of the *valley* here consists of *granite*, and its bottom is covered with *blocks*, scattered among rocks, all likewise of *granite;* and between these flows the *Bode*, which issues from the mountains at *Thal*, and thence continues its course to *Quedlinburg*.

385. But the object which here attracts the curiosity of travellers is an obelisk of *granite* rising from the bottom of the valley on the same side on which we had approached it, against the wacke that

composes the mountain; this is the rock commonly known by the name of the *Rosse-trap*, from a *cavity* in the summit, bearing some resemblance to the *print* of a *horse's foot*, respecting which there is the following ancient legend: that a princess, flying on horseback from a ruffian who pursued her, and not being acquainted with the road, arrived at the brink of the precipice on the opposite side of the deep cleft, across which her horse attempted to leap; but that, only one of his feet reaching the top of this rock, where he left the impression of his shoe, he fell with the princess down the precipice: the legend adds that a golden crown, which she had worn on her head, is still at the bottom of the *cauldron*, as it is called; this is a very deep pit, full of water, at the foot of the obelisk. Though the rock itself had been my object, I was however willing to see the cavity whence it derives its name: it rises considerably above the ground on the side of the cleft with which it is connected; but I was assisted in gaining its summit by a projection, whereon the wind had not permitted the snow to lie; and I thus obtained a view of the *Rosse-trap* properly so called, which really has nearly the form of a horse's foot; but the *horse* must have been that of GARAGANTUA.

386. This pyramid, which rises to so great a height from the bottom of the valley, is composed of a single mass of *strata*, very distinct, and nearly *vertical*. It is impossible to discern the junction of

these *granitic strata* with those of *wacke*, which encompass them, because it is concealed by a slope composed of the rubbish of the latter; besides, when I was there, this slope was covered with snow: thus I could observe nothing more than the nature of the granite, which participates in that of the *blocks* that I had seen on the road to *Blankenburg*, since it contains the same block *schorls;* yet in other respects it differs from those blocks, at least from such as I had remarked; for I perceived in it laminæ of *mica*, of considerable size, and very brilliant. These are some of the *inferior strata* of *granite*, which have been here laid open to view by the strange succession of catastrophes undergone by the whole mass of the *strata;* and of this I shall give another example in the sequel of the present journey. As for the *blocks* which are scattered on the exterior side of the *Hartz*, they must necessarily have been expelled from within during those catastrophes; for they cannot have been transported to their present situation by the impulse of the waters. The *Bode*, which flows at the foot of the *Rosse-trap*, assumes afterwards a quite different course; and this rock is separated from the places where I had seen the *blocks* by several chains of mountains, on observing which, it is impossible to doubt of their having been themselves produced by the same catastrophes.

387. On my return to *Blankenburg*, the weather having cleared up, the same guide conducted me to

view two objects which had been mentioned to me as very remarkable; one of them was called the *Düvelsmaur*, (the devil's wall,) and the other, the *Regenstein*. The first of these presented to me, on a large scale, what I have already described on a small one in the hills at the foot of this chain; namely, a long line of rocks which rise above the summit of a hill, and which when viewed in perspective from a distance, have very much the appearance of a large ruinous wall. On following this wall, I found it to consist of a mass of *strata* of *sand-stone;* which mass, at the time of the *subsidence* that took place in the front of this mountain on the outer side of the chain, remained at a higher level than the rest; but, in consequence of its own fractures, has since been reduced into a kind of large pillars. This is not a very rare phenomenon; and in the course of these Travels, I shall give examples of it in other classes of *strata*.

388. The *Regenstein* is a hill composed of the same *strata* of *sand-stone*, situated beyond the foot of the *Hartz*, at a league's distance from *Blankenburg*. There has been a fort on one of its extremities, which is cut down precipitously all around, in some parts to the level of the *sandy* plain that encompasses it. This extremity is separated by a deep cleft from the rest of the hill, which is everywhere studded with pointed rocks; and these, in some places, are arranged in such a manner as also to appear like walls. In a word, the whole of the

space here bordering the *Hartz* is intersected with the ruins of *strata* of *sand-stone;* and M. Von Hunger, on examining the *sand* of the plain, and comparing it with the *sand-stone*, had formed the same opinion as myself, that the former is not the product of the decomposition of the latter.

Dec. 9th. I had a recommendation to Count Von Stolberg-Wernigerode, whose lands, bearing this name, extend into the interior part of the *Hartz*, as far as the *Blocksberg*. At noon, I set out from *Blankenberg* for *Wernigerode*, which is still on the confines of those mountains, but farther to the westward. The road passed over small hills covered with *sand*, and cultivated. The *stony strata*, but seldom exposed to view, were at first of the same *sand-stone* which I had seen prevail from *Halberstadt* to *Blankenburg;* afterwards, however, I observed *strata* of *lime-stone*, covered also with *sand*, and in a position nearly *vertical*. At *Wernigerode* opens the *valley* which leads most directly to the *Blocksberg*; and as I ascended the hill whereon the castle stands, I saw the summit of that mountain (the highest of those composed of *granite*) rising at the upper extremity of the valley, into which advance several branches of the chain. The castle-hill, nearly insulated, particularly attracted my attention, its mass consisting entirely of a heap of rubbish of every kind, *lime-stone, wacke, granite*, and other primordial stones.

389. I reached the castle at three o'clock; the Count was unluckily absent, and the Countess was at another of his seats at *Ilsenberg*, to the westward of this, though also on the foot of the *Hartz;* but I had the good fortune to find here M. BENTZLER, the Count's secretary and librarian, who was a very intelligent man, and most kindly gave me all the information which I desired. Two vallies descend directly from the foot of the *Blocksberg;* one of these, though it has many windings, yet varies but little from its original direction, and terminates at *Wernigerode.* A small stream called the *Holzemme* issues from this valley, and discharges itself, some way below *Halberstadt*, into the *Bode*, which also proceeds from the *Blocksberg*, and which I have lately described in the higher part of its course, where it precipitates itself into the deep valley of the *Rosse-trap.* From the other valley, more serpentine in its course, and terminating at *Ilsenburg*, issues the small stream *Ilse*, which likewise joins the *Bode*, but lower down, at *Oschersleben.*

390. Such then are the principal *streams* proceeding from the *granitic* region of the *Hartz;* and had those mountains really been the source of the *blocks* of *granite* which are scattered in such prodigious quantities over the countries lying to the westward, and extending northward as far as the gulph of the *Elbe*, these are the only waters by which they could have been transported: in this case, therefore, according to Mr. Playfair's opinion,

it is near the *issues* of the above streams from the mountains, that the *blocks* should be found in the greatest abundance. Now I never saw fewer blocks, in any part of this country, than on the road from *Blankenburg* to *Wernigerode;* and the *Holzemme*, one of these streams, the bed of which, near the latter place, serves as the high road, has nothing on this bed but rounded fragments of *grey wacke*, mixed with a very few of *granite* and other stones of that class; nor does it bring down any thing else during its inundations. From the castle, I descended to the town of *Wernigerode*, where, by M. Bentzler's desire, I called on M. Blum, a Counsellor of the Regency, who was so good as to give me a letter of recommendation to M. Wurtzbach, Counsellor of the Mines at *Ilsenburg*.

Dec. 10*th*. At eight in the morning, I set out out from *Wernigerode* for *Ilsenburg*. The road continued to follow the foot of the *Hartz*, where the effects are everywhere to be seen of the *subsidence* which produced, not only the *vallies* in the chain, but likewise the *plains* adjacent to it. This foot of the *Hartz* chiefly consists of small hills of *schistus*, broken into pyramids of various sizes, and intermixed with others of different species. The upper part of these hills was covered with woods, which were bordered by fields overspread with fragments of *lime-stone*. I still saw but very few *blocks* of *granite* on this road, till I came to the village of *Drübeck*, where they lay in great abundance.

Near this place, I passed through an oak-wood, extending over a large eminence, which is distinct from those just mentioned, and which slopes down to *Ilsenburg*, forming the left bank of the small river *Ilse*, at the entrance of its valley. As the surface of this eminence was covered with *blocks* and smaller masses of *primordial stones*, I was desirous to be better acquainted with it.

391. I reached the castle of *Ilsenburg* at 10 o'clock; but it being as yet too early to see the Countess, I gladly availed myself of M. Würtzbach's obliging offer to accompany me in whatever observations I wished to make in the neighbourhood; and I accordingly set out with him, to view first the above eminence. A cliff, at the foot of which flows the *Ilse*, afforded me an opportunity of seeing that the mass of this hill consists of *strata* of foliated *marl-stone;* these *strata* being strongly inclined, the summit of the hill is formed by their sections, though covered as I have just said with masses of *primordial stones.* At the top of the cliff appears the section of this superficial stratum, extraneous to the mass of the hill: towards the highest part, it is not above two or three feet in thickness; but lower down, on the sides, it is five or six. The nature of the stones renders it very evident that those, which are here found on the bed of the *Ilse,* must have fallen from the cliff. On the bottom of this entrance of the valley, rise several small mounts, composed of the same *strata*

as the hill; whence it clearly appears that a *subsidence* of these *strata*, has here taken place; and I learnt from M. Würtzbach, that this kind of *calcareous stone*, which is subject to decomposition by the air, extends as far as *Drübeck*. We walked over the upper part of the hill, where I remarked that the oak woods had been preserved only in places where the quantity of stones was too great to allow any other use to be made of the land; for in a higher part, which advances towards the *schistose* mountains, and in which the superficial stratum of these stones was originally of less thickness, the *blocks* have been cleared away, and the soil has been brought into cultivation. Having seen, among these large stones, some masses of *granulated quartz*, I inquired of M. Würtzbach whether there were any *strata* of that stone in the higher regions of the *Hartz*; but he told me that there were none in any part of that chain. We advanced as far as the brow of the hill, on the side where it descends rapidly towards a small vale, which separates it from the foot of the mountains of *schistus*. We descended into this vale, and found that its soil was of a reddish clay; nor did I perceive in it the smallest trace of the stones which were so abundantly scattered on the hill. Beyond this begin the fir woods which cover the slopes of the *schistose* eminences.

392. On returning to *Ilsenburg*, I had a very obliging reception from the Countess, whom I had

the honour of seeing with the young Countesses her daughters; and she invited me to remain at the castle as long as might be convenient for my plans of observation: I accepted the invitation for this day with much pleasure, because M. Würtzbach had told me that a league above the entrance of the valley, the sides of which consist only of *wacke* and *schistus*, there was a very remarkable phenomenon of *granite*, differing considerably in its circumstances from that of the *Rosse-trap:* we accordingly went in the afternoon to view this phenomenon; and M. VON FELTHEIM, a canon of *Halberstadt*, who happened at present to be at *Ilsenburg*, and was well acquainted with these mountains because he sometimes sported there, desired to be of our party.

393. We first, through a fir wood, ascended the foot of a mountain of *schistus*, on the right bank of the *Ilse;* then, turning into a path cut in slopes of rubbish of *grey wacke*, which are covered with wood, and rise to as great a height in the mountain as the eye can reach, we advanced towards the object of our walk. The path led us across ravines, where vegetation had not yet been able to establish itself, because their foot was attacked and sapped by the small stream during its inundations; in consequence of which, the whole surface of the slope from time to time slipped down, and the path being in those parts carried away, it became necessary to cut another. This is still the

case, among mountains, with many slopes of rubbish; which will continue to be thus attacked, until they shall retire so far backward, in consequence of these falls of materials, as that their base shall no longer be within reach of the streams which flow near them; their surface will then be bound by vegetation, as I have already remarked in many places; and I shall give new examples of this process in the following Travels.

394. After we had walked on for some time in fir woods, and crossed these ravines into which they had not been able to extend themselves, our path the whole way, lying over the slopes of mountains consisting of *schistus* intermixed with *grey wacke*, we came to a spot of a very singular appearance. The slope was here covered, from the top, with immense masses of *granite*, down to the *Ilsenstein*, which was the particular object that we were come to observe, being a promontory projecting about 100 feet from the side of the valley composed of the above materials, and rising about 30 above the level of its bottom. In the *Ilsenstein*, the *strata* of the *granite* do not appear as in the *Rosse-trap*, for it consists only of large masses piled one on another; and I saw a great quantity of similar masses on the slope of the opposite hill, where they also ascended to the summit.

395. Let us now more particularly consider the situation of this great phenomenon of *granitic* masses;

es; and whether, though they are found in the
bourhood of mountains of *granite*, it is pos-
that they can have proceeded thence. On
ng, from the *Ilsenstein*, up the very tortuous
in which it stands, the direction of this
is seen to be crossed by successive ridges of
tains projecting alternately on either side.
hese mountains consist of *schistus* or *grey*
e; and the *Blocksberg*, the highest of the
itic summits, rises towards the head of this
itheatre. I was told by the gentleman who
npanied me that it was about three hours walk
the *Ilsenstein* to the *Blocksberg*, over these
s, between which the little river flows in
w channels, wherein it must evidently always
flowed; for, on observing the situation of the
a in all these mountains, and in the promon-
which advance from them and produce the
inflections of the *valley*, it cannot be doubted
the various forms of the surface have here en-
resulted from the ruptures, partial subsidences,
angular motions, of the separated masses of
a of *schistus* and *grey wacke*, which extend
r as the present foot of the *granitic eminences*.
, though the phenomenon of the *Ilsenstein*,
the immense quantity of the *blocks* of *granite*
nd it, is at the distance of only three leagues
those *eminences*, it cannot have proceeded
any other cause than that which has produced
imilar phenomena already described in so many
es at an immense distance from every *eminence*

of this kind: I mean to say, that these *blocks* must have been expelled from within, by the *expansible fluids* compressed during the *subsidence* of the large masses of *strata*. Hence we returned to *Ilsenburg*, where I passed a very agreeable evening.

Dec. 11*th*. For my return to *Brunswick*, I took the shortest road, by *Wolfenbüttel;* which gave me an opportunity of observing another part of the foot of the *Hartz*. I set out from *Ilsenburg* at 7 in the morning, and travelled, for some time, either over small hills, or at the bottom of a vale wherein flows the small river *Ecker*, which also proceeds from the *Blocksberg*, issuing from the western foot of that mountain. I passed, first through the villages of *Stapleburg*, and *Abbenrode;* and at half past 10, I reached that of *Wiedelah*, where the postillion stopped to feed his horses.

396. All the country which I had here crossed, as well on the heights as in the lower parts, is so abundantly covered with fragments of *wacke*, mostly *grey*, that only a few spots, here and there, have been found capable of cultivation; and in these, the stones taken out of the land are heaped up along the sides of the fields. The soil over which these fragments are scattered appears to consist of clay; at least I saw clay dug out at *Stapelburg* for the purpose of making bricks. The land being of so little value, the small river *Ecker* is not restrained

by banks in the vales through which it flows; so that it changes its bed during every inundation, and preserves no certain course. The bottom of these vallies is covered with stones, not, however, brought down hither by the river, since they are of the same kind as those found in all the neighbouring soils, whether in high or low situations; the stream has therefore merely washed away from the stones on its course the clay which happened to be mixed with them, and has thus left them exposed to view; as is the case on the beds of all rivers flowing in plains.

396. *a.* After having passed over the lands which I have just described, there is great pleasure in arriving at *Wiedelah*, one of the prettiest of rural villages: it is built around a large grassy plain, and consists of very neat houses, to each of which a garden and an orchard are annexed. The plain is a common, the property of all the villagers; and it was covered with flocks of geese, and other kinds of poultry. From the window of the inn, where the postillion had stopped, I had a very fine view of the *Hartz*, commanded by the *Blocksberg*, which from whatever quarter that chain is approached, is seen to tower above all its other eminences. As there were light vapours in the *vallies*, they rendered it easy to distinguish all the successive ridges of *schistose* mountains which rise up to the *granitic* region.

397. The *Ocker*, which passes through *Wolfenbüttel* to *Brunswick*, rises also in the same granitic mountains: it begins to bear this name near *Altenau*, to the west of the *Blocksberg;* and, like the rest of those rivers which are distinguished by names in the maps of these countries, it is an assemblage of all the small streams descending from the parts of the mountains near which they flow; but it does not receive the *Ecker*, till it arrives at *Dorstedt*, situated in a large plain extending from *Wiedelah*, by *Heinengen*, almost as far as *Wolfenbüttel*. Plains of this kind, when intersected by rivers issuing from mountains, afford the same proof which we find in *lakes*, that the masses of stone scattered over the countries lower down on the course of the rivers have not proceeded from those mountains; for could they even have been brought to this distance thence, which I have shewn to be impossible, they would have been deposited in these *horizontal* spaces, where the waters spread themselves during floods, in the same manner as they are in the basins of *lakes*. Now here it clearly appears that nothing but minute *gravel* has been deposited in this plain by the *Ecker* and the *Ocker*, ever since they began to flow; and that, when these small streams, following their customary course, had worked their way through their own sediments, and formed permanent beds, a little below the level of the plain over which they had spread this *gravel*, the latter was covered with grass, and is now in some parts cultivated. I crossed the *Ocker* a little before I came to *Heinen-*

gen, whence I proceeded, over higher ground, to *Wolfenbüttel*. There I observed *blocks* of *granite* with other stones of the same class; the causeway is paved with smaller masses of all these stones; and along the fields, and in the villages, I saw some very large *blocks* which had been taken out of the grounds cleared for cultivation.

398. I have now followed all the streams descending from the *granitic* region of the *Hartz*, these being the only channels which can possibly be supposed to have afforded a passage to the *blocks* scattered to so great a distance over the countries to the west and the north of these mountains; and it has been seen that every thing here is directly contradictory to such an hypothesis. It is true that there are heaps of *granitic blocks* in some parts of these *vallies;* but only for the same reason as equally large accumulations of them are found in some parts of the above countries consisting entirely of sandy plains and hills; and the circumstance which I have pointed out in the latter as so opposite to every idea of the *migration* of *blocks* from any distant place, namely, that, between the spaces where they lie in this prodigious abundance, there are intervals in which we meet with none, is observable at the very foot of the *Hartz*, in that large horizontal plain, where the *Ecker* forms a junction with the *Ocker:* both these streams descend from the *granitic* summits; hence it is evident, that, had they been able to bring any *blocks* along with them thus far, they

must necessarily have deposited them in this plain, where, however, none appear. Lastly, that the *blocks* which are found on the outer side of certain chains of mountains have not proceeded thence, is proved by the differences in the genera and species of these blocks, and of the stones belonging to the mountains. Now I have already mentioned the masses of *granite* containing *black schorls*, with the other masses containing *garnets*, and those of *granulated quartz*, to all of which this observation is applicable; but besides, at *Heidengen* commences the general phenomenon extending over all the countries to the west and the north of the *Hartz;* namely, that of the great variety of beautiful *primordial stones*, of kinds which are not found in any part of this chain.

Dec. 12*th.* I spent the morning at *Wolfenbüttel* with M. LANGER, Director of the celebrated Library of that place, with whom I had had the pleasure to become acquainted at *Brunswick;* and who, after I had seen the library, was so good as to shew me the principal parts of the town. This is the entrance of a country consisting of *strata* of *lime-stone*, over which I have frequently travelled. The *strata* rise here in several hills; and their situations leave no room to doubt that the *vales* and *plains* lying between those hills have been produced by *subsidences.* Over these ruins of *strata* are scattered many fragments of their own species, and of *primordial stones;* the town is paved with masses of both these kinds, and along the houses are large *blocks* of the latter. The *Ocker* follows the vales of these hills, by the projections of which its course, in some places, is much narrowed; but in general it flows in wide spaces, where it is bordered with meadows, still subject to inundation when its waters are swelled. The wood of the mountains is carried down this river in rafts as far as *Brunswick;* a circumstance from which some judgment may be formed of the small declivity of of this part of its course. Below *Brunswick,* the *Ocker* unites with the *Aller,* which arrives from countries to the eastward of the *Hartz;* and they both flow together to join the *Weser.*

399. *Wolfenbüttel* being at the distance of only two leagues from *Brunswick,* I have frequently walked from one of these towns to the other. Near *Wolfenbüttel* is a considerable space where there are no *blocks;* but they again appear on the top of the hill near *Brunswick;* and in the descent towards the latter town, the stone-posts along the causeway, which are either entire small *blocks,* or fragments of very large ones, consist of a great variety of *primordial stones.*

JOURNEY *from* BRUNSWICK *to* BERLIN, *through the* ALTE MARCK.

400. THE study of the operations of *rivers* along their course forms an essential part of that of the history of the *continents* themselves; and for this purpose, as I have already said, I had made choice more particularly of the *Elbe*, as flowing through a large tract of the countries within my plan of observation. Having occasion, therefore, to travel from *Brunswick* to *Berlin*, I took the road which passes through the *Alte Marck*, because, in this road, the *Elbe* is crossed at a greater distance than I had yet seen it from its discharge into the sea.

March 4th, 1798. I set out from *Brunswick* at 7 in the morning for *Steimke*, at the distance of 4 miles, the 2 first of which terminate at *Flechdorf;* where, however, I did not arrive till 10 o'clock, because the roads consisted of deep sand. The whole of this country is cultivated; in clearing the fields, the *blocks* taken out of them are laid along the sides of the road; and in the villages, these all consisted of *granite* and other stones of that class, with some masses of *granulated quartz;* but there were not many of them. Having observed in the walls of the houses at *Vorsfeld,* where the postillion stopped to feed his horses, a kind of *sand-stone* of a rusty yellow, I walked on to examine the hill, from the top of which I was told it had been taken. I accordingly came to a high part of the road, and saw a cleft, where the *strata,* of this stone, in great disorder, were open to view. A brook took its course through this cleft; and on its bed there was gravel of the finest *primordial stones,* among which I found in particular a piece of *granite,* singularly beautiful from the lively colour of its red *feld spar,* the transparence of its *quartzeous crystals,* and the brilliancy of its specks of *mica.* I had sufficient leisure for observation; for I proceeded a long way before my chaise overtook me; and the postillion afterwards drove so slowly, that it was 5 o'clock when we reached *Steimke;* thus I had spent 10 hours in travelling these 4 German miles.

401. The last part of this road was over a plain a little undulated, and interspersed with small hills, the whole consisting of sand, in some places argillaceous; the greater part of this soil is cultivated, but it is by no means fertile; and I saw everywhere, by the sides of the road and in the villages, the *blocks* which had been taken out of the arable fields; but those in the pasture-grounds had been suffered

to remain there, overspread with lichens. Over the sand are disseminated abundance of *flints* of the finest colours, red, yellow, and black; among which I found the nucleus of an *echinite spatangus.* A small stream passes along the foot of a hill near *Steimke,* and is used for steeping flax in pits made for that purpose along its course. I saw a great many *blocks* of *primordial stones,* which were laid on the flax to keep it under water. I spent the night at this village.

March 5th. At 5 in the morning I set out from *Steimke* for *Gardeleben;* and though this distance was also 4 miles, I was only 4 hours in travelling it, because the road was not so bad, and I had better horses. In the 3 first of these miles, I saw scarcely a single *block;* the country here consists of sand, and is in most part planted with woods of pines and birches; the rest is cultivated, or covered with heath. I quitted my chaise at the half-way house, and walked on while the horses were feeding. Here I observed a change in the *gravel,* which now consisted only of *grey wacke,* mixed with some *granulated quartz;* but it still contained the same beautiful *flints.*

402. From *Gardeleben* I set out at half past 10 for *Tangermünde,* at the distance of 5 miles. Within this space, there was a vast quantity of *blocks* of primordial stones, in some places scattered, in others forming great accumulations; and the

following example will shew how much they varied in species. I saw laying almost close to each other two very large *blocks*; one of these, from a distance, might have been taken for a *breccia*, on account of the prodigious size of its crystals of *white feld-spar*, which were very conspicuous on a ground composed of small crystals of *grey quartz* mingled with *mica*. At the same time the adjacent *block* consisted of minute crystals of *feld-spar* of a very bright *red*, and crystals of *semi-transparent quartz* mingled also with *mica*. After the many facts which I have already adduced to demonstrate that these masses must have been thrown out from within during the catastrophes of the *strata*, such marked differences among those scattered on the surface, in the same places, manifestly shews the variety which prevails among the inferior *strata*.

403. At half past 4, I arrived at *Tangermünde*. This town stands upon a hill, on the left bank of the *Elbe*; and the right bank being in this part very low, it affords a large space over which the river can spread during floods. The hill itself originally formed a promontory here, and repelled the stream; but, as I have shewn in similar places lower down on its course, by sapping the foot of the promontory composed of *sandy strata*, and causing it to crumble down from the top, the *Elbe* has reduced it into a cliff, and has thus procured for itself a freer passage, carrying over the *sand* to the opposite side. The cliff is about a quarter of a league in

length; the church and the Amtmann's castle stand on the top, not far from the edge; and in order to secure them, a strong wall, with strong buttresses, has been built at its foot; but the *Elbe*, having now a free course in front of this cliff, has almost ceased to attack it anywhere; and I saw several parts of it which were reduced into slopes, and covered with grass.

March 6th. I embarked at *Tangermünde* at 6 in the morning, in order to cross the *Elbe*, which was then very broad, being much swelled; yet the boatman pushed on the boat the whole way with a short pole reaching the bottom; for the water was in no part above 6 feet in depth. This surprized me the more, because he had told me that the river was at this time 4 or 5 feet higher than in summer; and I inquired of him how it was possible for barges very deeply laden to ascend it at that season. Now his explanation will fully exemplify what has happened on the courses of all rivers which flow between hills consisting of *loose strata*, since their waters have been collected in streams.

404. During the inundations of the *Elbe*, the sand put in motion on those parts of its shores which are not bound by vegetation is spread over its bed, where it forms *sand-banks;* and these, by degrees, following the course of the stream, fill up the channels into which it sinks at the time when the water is low. But when it becomes low again, the bearing of the

coasts always giving to its current the same direction, the river, now reduced in breadth, begins to carry down the sand by which its bed had been raised; and in this manner it hollows out for itself a channel not less than 16 feet in depth.

405. It is thus that the *Elbe*, which flows, the whole way from *Saxony*, between hills composed of *strata* of sand, intermixed with others of clay, and of marl, having attacked them in all the parts where their projections obliged it too suddenly to bend, and there causing them to crumble down, has been continually carrying on the materials which have fallen on its bed to parts successively lower on its course. Hence have resulted the very extensive tracts of *alluvial soil* on its borders; because such materials as can only continue to float in parts where the water retains a certain motion have been deposited wherever it has had room to spread; while the particles still borne along by the stream have been carried down farther. It is by these particles that the gulph of the *Elbe* has been so much narrowed between *Holstein* and the country of *Bremen;* and that, on the former side, its sediments have even extended along a part of the coast of *Sleswigh.* There is a large tract of *alluvial* land on the side opposite to *Tangermünde;* and, in a future journey, I shall have occasion to speak of soils of the same kind which lie on higher parts of the course of this river; but all great operations have been for some time at an end, in conse-

quence of the retreat of many cliffs, now covered with vegetation; so that the stream has no longer, by any means, the same quantity of materials to transport.

406. My carriage, with horses from *Tangermünde*, having been ferried over the *Elbe*, I immediately set out for *Rathenau*, at the distance of 3 miles. I have already said that, on this side, the bank was originally low; it had been levelled by the waters during floods, before the alluvial soils, added to it by the river, were enclosed with dikes. This appears very manifestly after passing over the latter soils, which are of considerable breadth; for there is only a small ascent from them to the original soil, consisting of *sand* mixed with many kinds of *stones*. Proceeding on my way, I observed but very few *blocks*, till, a little before I reached *Rathenau*, I came to a village in which great numbers were collected together.

407. *Rathenau* is a very pretty small town, on a soil but little elevated, in every part of which the sand is so loose as to be raised up in *dunes;* so that the town appears as if situated among the *dunes* of *Holland*. I here entered that part of *Brandeburg* where there are so many *lakes*, large as well as small, on the courses of all the rivers; the chief of which are the *Spree*, arriving at *Berlin* from the eastward, and the *Havel*, joined by the former near *Spandau*, whence they both flow united

to discharge themselves into the *Elbe* below *Tangermünde*. In my Travels lately published, I have described the *lakes* of the *Havel* and of the other rivers passing through *Mecklenburg;* and, by the different circumstances that accompany them, I have shewn them to belong to the number of those phenomena which so irrefragably prove the small antiquity of our continents. I crossed the *Havel* near one of its *lakes*, before I arrived at *Rathenau*.

408. I set out at noon for *Barnewitz*, at the distance of 3 miles. Here I again travelled over a low sandy soil, which is often quite flat, but is sometimes interspersed with a few small hills. Along this whole road, I saw very few *blocks*, either on the lowest or on the more elevated parts. I arrived at *Barnewitz* at half past 3: but not finding any horses there, I was obliged to spend at that town the remainder of the day.

March 7th. As I was desirous to reach *Berlin* early, I set out from *Barnewitz* at half past 4 in the morning; my first stage being to *Wustermarck*, a distance of 3 miles. This road passes through a beautiful forest of pines, in which I travelled for two hours. The whole country here consists of sand; in this part of it, I found no *blocks*, nor scarcely any smaller stones; but on coming afterwards to fields, I saw there some scattered stones: these however were neither of *granite*, nor of any kinds belonging to that class, being only of gray *wacke* and *granulated quartz.*

409. At half past 8 I reached *Wustermark*, and at 9 I quitted it for *Berlin*, at the distance 4 miles. As far as *Spandau*, there were scarcely any *blocks;* but the smaller stones, among which I began to distinguish *granite*, were scattered in greater abundance. From *Spandau* to *Potsdam*, the *Havel* is properly a long *lake*, winding between hills, where it is bordered, to a greater or less breadth, with meadows. In the neighbourhood of *Spandau*, I saw *blocks* of *granite* and other stones of the same class, and their quantity increased, as I approached, first *Charlottenburg*, and afterwards *Berlin*, at which city I arrived about 2 in the afternoon.

I made at this period, a long stay at *Berlin*; where, having been elected a foreign member of the *Society of the Investigators of Nature*, I engaged in those pursuits of experimental philosophy, which then occupied the public mind.

Some time after my arrival at *Berlin*, I received from M. Cavallo and Dr. Lind, the first accounts of the celebrated *Galvanic* experiments, brought by the *Pile* of Sig. Volta, to a point in which had they had assumed an appearance entirely new, and very important. These phenomena strongly interested me, that I determined to glect nothing for the purpose of deeply analyzing em; an object which led me, in the first place, to sume the analysis of simple *electric* phenomena; d here I discovered so many links of connexion th every branch of *terrestrial physics*, that my nd was naturally carried back to the principles of *tural Philosophy* laid down two centuries ago by first master in that science, the immortal CON. From these combined pursuits, resulted three following works, which I sent to *Paris*, ere they were published.—*Introduction à la Phyue terrestre par les Fluides expansibles.—Précis la Philosophie de Bacon, ct des progrès qu'ont it les Sciences naturelles par ses préceptes et son emple.—Traité élémentaire sur le Fluide electrolvanique.*

During this period, I likewise made from *Berlin* any geological excursions; several of these have en already related; but there are still remaining o, which are very important, because they were nong mountains composed of *primordial strata*, chains to the eastward of the *Hartz;* and I shall w proceed to give an account of them.

---

410. Before my arrival at *Berlin*, I had heard me confused account of a system relative to the

previous idea; but at *Berlin* I had the pleas becoming acquainted with its author, M. MEIER Professor and Head of Joachim College, a member both of the Academy of Sciences, a the Society of the Investigators of Nature. I conversations on the subject of Geology, he exp to me his system, of which I shall endeavo the first place, to give some intelligible accour

411. This system had been suggested Meierotto by a fact, which in these countries ticularly striking, and which I have frequen duced in opposition to the hypothesis of the *tion* of *blocks* on our existing continents; the vast abundance of *primordial stones* her tered on the surface, though of species not in the *mountains* to the south of the *Baltic*; which consequently cannot be conceived been, by any cause, brought from those *mo* But stones of similar species are found Swedish mountains, on the north of the and to these therefore M. Meierotto had his attention. He had had opportunities of s winter, on the coast of *Pomerania*, that, w sea is at its lowest level, the *ice* formed on it encloses some of these *blocks*; afterwards of the water rising, and the *ice* breaking

borders, detached masses of it containing these *blocks* are cast up on the *strand*, where, when the ice melts, the blocks remain. Such were the data of his system, which he arranged in the following manner.

412. He supposed that, at the birth of our continents, the whole north of *Europe* was covered by a *sea*, which was kept at a *high level* by chains of rocks, forming a kind of dike around it; that within this basin were formed the *secondary strata*, both *calcareous* and *sandy*, and likewise the others called *tertiary* by some mineralogists: that, in consequence of ruptures in the dike, portions of this *sea* rushed down with impetuosity into lower basins, the dikes of which, in their turn, were also broken; that the *blocks* now in question are fragments of these dikes; and that in each of the basins thus differing in height, before any ruptures of its own dikes took place, the fragments which had been brought down into it by the rush of the waters, having been carried to its borders by the *ice* in the manner described above, had remained there at different levels determined by the gradual subsidence of this *sea*, of which the *Baltic* is now the residue. He allowed that it was impossible to maintain the gradual *excavation* of *vallies* by *running waters*, because that operation was not seen at present to continue; but he considered his own system as affording a cause fully adequate to their production, by the sudden rushing down of this elevated sea at the points where the dikes were broken.

413. It was undoubtedly necessary to allow an incalculable time for these operations, on continents already existing because no trace of any such events can be found in the history of nations. But M. Meierotto was not deterred by this consideration, for the usual reason, that time past has no limits. It was not therefore under this point of view that I attacked his system; but having then particularly present to my mind my observations among the *mountains* of the *country of Neufchatel*, which form a part of the *calcareous* chain of the *Jura*, I mentioned to him the facts whence it so manifestly appears that the *vallies* of this chain must have been produced by the ruptures, partial subsidences, and angular motions, of the *strata;* and that, not only from the great number, but from the singular positions, of the *blocks* of *granite* disseminated over these ruins of *strata*, it was impossible not to be convinced of the ejection of these blocks from within, by the *expansible fluids*, violently compressed during the descent of the immense masses which had *subsided.* He did not adduce any argument against the possibility of these operations, but contented himself with telling me that, supposing this to be a sufficient explanation of the phenomena of the *Jura*, the case was very different with respect to those of the mountains of *Germany*.

414. The controversy being brought to this point, it could not possibly be carried on any farther, unless we were in possession of some common facts.

The situation held by M. Meierotto put it out of his power to visit the places to which I had referred; but those mentioned by him were within my reach; I determined therefore to go to observe them; and I had soon an opportunity of viewing some of them in company with himself. He had told me of a spot, at the distance of three miles from *Berlin*, which he considered as entirely at variance with my idea that the *blocks* of stones scattered over soils of extraneous natures, remote from every mountain where stones of the same kinds now occupy a place, had been expelled from beneath these soils. This was a vast *uninterrupted* tract, consisting of *lime-stone strata* at a small depth beneath the *sand*, over which are scattered great quantities of *blocks* of *granite*. I inquired of him whether this tract was *hilly*, or *flat*; he replied that it was *hilly*, and that in one of the eminences there was a large quarry. On this I told him that, from my intimate acquaintance with *hilly* countries, I entertained no doubt of these being merely *ruins* of *strata*, which, unless covered with a very thick loose soil, would afford the same proofs as are every where to be found, that all *eminences* owe their existence, under that form, to the subsidence of the soils around them: I added, that, since there was a quarry where the *calcareous strata* were laid open to view, their state must there evidently appear; and that this was therefore a spot which we ought to visit together. M. Meierotto readily agreed to my proposal, and we fixed a day for our excursion.

EXCUR-

EXCURSION *from* BERLIN *to the lime-stone quarries of* RUDERSDORF.

May 26, 1798. M. Meierotto and I set out together from *Berlin*, at 5 o'clock in the morning, for these quarries, the distance of which from that city is, as I have said, three German miles. As far as the hills, we travelled over a country consisting wholly of *sand*, strewn with great quantities of granitic *blocks*. When we approached the hills, their form enabled me to judge of the situation of their *strata*, and I pointed out their characters to M. Meierotto; in each of these eminences one of the sides was abrupt, and that opposite to it extended in a gentle slope; from which it was evident that, on the former side, there had taken place a *fracture*, accompanied with the *subsidence* of the part detached from the mass of *strata* now remaining at a higher level; these *strata* having, at the same time, assumed an *inclination* towards an opposite *vale*, which had been produced by a similar *subsidence*.

415. These effects were laid open to view in the hill where the quarry was: this hill is elongated, and its slope is in the direction of its length. The quarry was first opened, to a considerable width, at the foot of one of the extremities of the hill; and as it has, for a long time, furnished stone to *Berlin* and the adjacent country, an artificial vale

has thus been formed, which divides the hill lengthwise, and of which the bottom has no greater slope than is merely sufficient for the discharge of the waters: in ascending this vale, its sides become gradually higher as the slope of the hill rises; and the quarry-men always begin from the top to cut down slices of the stone of equal thickness, thus leaving sections of the *strata* on both sides. We went on to the end of this excavation, where the workmen had begun to cut a new slice; and having ascended by their path to the spot, we observed there the following particulars: The *strata*, which, as they contain *marine bodies*, must have been originally formed in the sea in a position nearly *horizontal*, have now an *inclination* of more than 40°, and a *direction* obliquely crossing that of the hill, the summit of which is formed by their *section*; hence it appears that, when broken off by a *subsisidence* on the side next one of the present *vales*, they acquired an inclination towards the other.

416. We then ascended to the summit of the hill; and having thus acquainted ourselves with the situation of its *strata*, we could easily judge, from the appearance of the hills around, that in all of them the strata had undergone similar catastrophes. Several of these eminences have been sounded; and in some, at a small depth beneath the rubbish of their rapid slope, there have been found *sections* of the same *strata*, inclined towards the side where the declivity is more gradual. These hills are covered

with sand overspread with heath, beneath which the *strata* are so much shattered, that, unless very deep excavations are made in them, few masses are found of sufficient size to be hewn for building; but fragments of them are used for the foundation-walls of houses, for enclosures, and for making lime.

417. While we were still on the summit of the same hill, having acquired from the foregoing circumstances some knowledge of the situation of the *lime-stone strata* in the country that lay within our view; clearly distinguishing there the cause of the *formation* of the *vales* which divide the hills composed of these strata, and bear no proportion, either in breadth or depth, to the small quantity of water that flows in them; finding lastly, on this summit, numerous fragments of *granite*, *blocks* of which we saw scattered on the slopes of the neighbouring hills, and in the vales between them; I asked M. Meierotto whether he did not here perceive the truth of my system respecting the origin of these scattered *blocks*; namely, that they had been ejected from within by *expansible fluids*, violently compressed during the general *subsidence*, as well of all the *lime-stone strata* of this country, as of those which lie beneath them, the *hills* composed of the former strata being only masses remaining at a higher level than the rest? He allowed that he had nothing to oppose to this explanation; he did not, therefore, persist in the objections which had induced him to accompany me in our present excursion, under the

expectation that, in this spot, he should meet with a confirmation of them. But recurring to the *great mountains* in *Silesia*, especially the *chain* of the *Giant's mountains*, (*Reisengebürge*,) he told me that when, from the summit of one of these, he had contemplated the immense *vallies* which lay between them, with the *torrents* which flowed down the slopes, propelling huge masses before them; and had, at the same time, represented to himself that of this chain all the *blocks*, *gravels*, and *sand*, disseminated to a great distance over the hills and plains, might once have formed constituent parts; it had not appeared to him that the quantity of these scattered materials was too great to fill up again the vacancies of all the vallies. He therefore remained in the persuasion that the summits of the Silesian mountains, and of those of *Sweden*, had formerly been covered by a *sea;* and that to the ruptures of the dikes of this sea, and to the actions of the *ice* at different levels, were to be ascribed the dispersion of the *blocks*, and the production, by trituration, of the *gravel* and the *sand*. He concluded by saying, that, if I had seen these phenomena as he had done, he had no doubt that I should have formed the same ideas.

418. To this I could reply no otherwise than by determining that I would myself go to observe these mountains; at which M. Meierotto expressed much pleasure, a proof of the sincerity of his own conviction. In order to be sure that I should visit the

same spots as he had done, he gave me written directions respecting my road, noting down, at every place, what were the principal objects to which I was there particularly to attend; and he gave me letters for the persons with whom he had made his own observations, requesting them to accompany me in mine.

419. I thus received every possible assistance in the course of this journey, with which I combined another plan. I had always wished to observe the district of mines belonging to *Freyburg* in *Saxony*, and to form a personal acquaintance with the celebrated mineralogist, M. Werner, who was one of the directors; our opinions having coincided on a very essential point in Geology, namely, the origin of *veins*. As this journey would besides lead me towards the *Elbe*, near the point of its issue from the mountains of Bohemia, I farther purposed to observe that part of its course; especially since it was one of the places where M. Meierotto, with other mineralogists of these countries, imagined that the chain had suffered a rupture, by which a *higher sea* had rapidly run off, carrying down with it the *granitic blocks* now found dispersed over the countries below this level.

420. I first, therefore, completed this latter course of observations, and afterwards proceeded to the *Giant's mountains;* where having followed the road which M. Meierotto had traced out for me, I

gave him, soon after my return to *Berlin*, a copy of my observations on that road, accompanied with remarks, tending to disprove the possibility of the operations supposed in his system, and to shew the reality of those which I had explained to him in our conversations, as founded on my observation of other mountains. When I put this paper into M. Meierotto's hands, I represented to him how much trouble I had taken, for the purpose, not only of observing such places as he had pointed out to me, but of submitting to his examination my own observations, with the consequences which I deduced from them; requesting, in return, that he would enter with attention into this examination, and give me in writing his critical remarks, as well on the facts themselves, as on their consequences. During eighteen months after that time, we were in the habit of seeing each other once a week at the meetings of the Society to which we both belonged; I asked him frequently whether he had begun these remarks; for some time, his answer was that he had not yet had leisure to attend to the subject; but at last he told me that he found it would be necessary to employ one of the college vacations in going himself to observe some of the facts which I had described; and which had happened to escape his notice; this intention, however, was never fulfilled; he died, and I joined with all his friends in very sincerely regretting him.

421. In the following account, therefore, of these Travels, I shall not take M. Meierotto's system for my principal object, it being little known except in the countries where it was first promulgated. However, as it had formed my principal inducement to undertake these observations, I shall occasionally mention it in those spots which its author had particularly pointed out to me, as affording support to his ideas; and thus it will serve at least to supply examples of the mistakes into which those may fall, who observe the objects of Nature on certain sides, without having been accustomed to consider them on all. Besides, many of M. Meierotto's ideas are admitted into other systems, the errors of which will therefore at the same time appear. In general, the countries comprized within this course of observations are very fertile in great geological monuments, on account of the *mountains* of *primordial strata;* and it is of much importance to compare their phenomena with those of the countries consisting of simple *hills*, in order to perceive the universality, as well of the effects of the causes assigned in my works to the revolutions which took place on our globe antecedently to the production of its present continents, as of the effects, equally manifest on all their parts both high and low, of those different causes, which I have indicated as the only ones that have been in action on these continents since their birth.

Journey from BERLIN *to* DRESDEN.

June 1*st*. 1798. I set our from *Berlin*, at 2 o'clock in the afternoon, in a chaise with post-horses; and as I was in a *sandy* country, similar to those others over which I had already passed in such various directions, I travelled all night, that I might the sooner reach a more interesting district. My first stage was to *Mittenwalde*, at the distance of three miles, and I arrived at that place at half past six. The soil here is mostly cultivated, though every where consisting of *sand;* and I observed in it some *blocks*. From *Mittenwalde* I set out at seven for *Baruth*, the first place belonging to Saxony, at the distance of three miles, where I did not arrive till three quarters after one in the morning. The road passes, almost the whole way, over loose *sand*, planted with pines; here I saw very few *blocks*.

June 2*nd*. I set out from *Baruth*, at half past two in the morning, for *Luckau*, the distance being again three miles, and I arrived there at half past eight. The road continued to pass for some way over loose *sand*, planted with pines; but afterwards I came to arable fields, with a more fertile soil. I still saw but few *blocks*, though I was now approaching *chains of mountains*.

422. At three quarters after nine, I set out for *Sonnenwalde*, two miles distant, and arrived there at three quarters after 12. There was but a very thin vegetation over all this part of the country; and perceiving in the soil some traces of the plough, I began to suspect what I afterwards found to be the case, that, in soils of this kind, rye is occasionally sown almost entirely for the purpose of procuring a thin stubble, which, by breaking the force of the wind on the sand, favours the growth of a little herbage; and this affords a pasturage to the sheep, very scanty certainly, but absolutely necessary in countries where there are no meadows. I still observed very few *blocks.*

423. I set out at half past one for *Elsterwerda*, distant three miles, and arrived there at seven o'clock. Great part of the road lies through forests of pines, planted in loose sand, in which some *blocks* appear. The country is interspersed with hills, and I found these become higher as I proceeded: from one of the highest, I saw mountains on the horizon; and inquiring of the postillion what they were, he told me they were the *Riesengebürge,* or *Giant's mountains;* consequently I was not now at any great distance from them; and as I had seen a sketch of their outline, I easily distinguished among them the *Schnee-koppe,* which is the most lofty summit of the chain. At 8 o'clock, I set out from *Elsterwerda* for *Grossen-Hayn,* two miles distant,

where I arrived at midnight. The greater part of the stage had been still in the sand; but this town is situated in a vale, which is covered with meadows.

June 3d. Having taken a little rest at *Grossen-Hayn*, I set out at half past six for *Dresden*, distant four miles, and arrived there at half past 11. Beyond the vale which I have just mentioned, the soil undergoes a considerable change, and the whole country assumes a very different aspect: the woods are finer, the fields more fertile, and the vales which intersect them are covered with rich herbage. The *sand* is here mixed with rubbish of *gneiss*, and with other kinds of gravel; so that it is much firmer, and consequently more productive.

424. Along this road, the *stony strata* do not lie at any great depth below the surface, in which I saw several excavations, made for the purpose of taking out fragments of them for building rough walls and enclosures; in some places these fragments were of *gneiss*, in others of *sienite*, the name given by M. Werner to a species of *granite*, which, instead of *mica*, contains small crystals of *hornblende:* I saw likewise *porphyry* in some parts. The mass of the several ridges of hills which I crossed is composed of these stones, belonging to *strata* in a most shattered state, yet distinguishable in various places, where they differ much in their *inclinations* and *directions:* some of these strata follow one of the slopes of the hill, and shew their *sections* at the

summit; while others, inclining inwards, present their *sections* on the side. In a word, I found in these *primordial strata* the very same effects of *fractures* and *unequal subsidences* which I have already described in the *strata* of *lime-stone* containing *marine bodies*. A part of the loose soil that covers these hills consists of decomposed *sienite* and *porphyry*; it contains some *blocks* of these stones, among others of *granite* and of *jasper*.

June 3d, 4th, and 5th. I remained at *Dresden*, where I had the good fortune to form acquaintance with several naturalists; especially with Baron Von Racknitz, a great lover and promoter of mineralogy, at whose house I saw a very fine collection of minerals; the Inspector Keuler, keeper of the cabinet of instruments belonging to his Electoral Highness; and Baron Von Block: it will appear in the sequel how much kindness I experienced from all these gentlemen.

425. In observing the pavement of *Dresden*, I no longer saw the great variety of beautiful stones, which renders those of the towns of *Brandeburg*, in the *sandy* districts, when newly washed by the rain, so interesting to a lithologist. The pavement of this city is chiefly composed of *sienite* and *porphyry*, mixed with some masses of *granite* and *basalt*. Thus it is not possible that the chains of mountains on this side can have been the source of those beautiful stones scattered over *Brandeburg*;

for in that case they would be found here, near the foot of these mountains; in which, besides, it will hereafter be shewn that no *strata* of the same kinds are to be found.

426. Immediately on my arrival at *Dresden*, I wrote to M. Werner, to inquire if he were at *Freyberg*, and whether, in that case, he would allow me to wait on him, and would favour me with his directions in my plan of observing that country, to which he had given so much mineralogical celebrity. Instead of answering me by letter, he came himself to *Dresden* on the 5th; and invited me in the most obliging manner to his house at *Freyberg*, whence he offered to accompany me in the excursion which I wished to make. But he proposed to me that we should first visit the valley of *Tharand*. This valley, from the plain, extends a considerable way among the mountains, and is no less interesting with respect to geological phenomena, than it is generally admired for its picturesque beauty: we accordingly determined to go thither the next day.

Journeys from DRESDEN *to the Mines of* FREYBERG, *and to* MOUNT BORSBERG *near* PILNITZ.

June 6th. We set out from *Dresden*, on this first excursion, at 7 in the morning. After travelling an hour, we entered a chasm in the mountains, where we found ourselves between precipitous rocks, covered, up to their summits, with trees and other verdure, growing on slopes which rise in successive amphitheatres. For in the intervals of the projecting parts, there are on both sides large recesses; so that the bottom of the valley, where the soil is very fertile, opens into several wide spaces, partly cultivated and partly in meadows, through which a small river winds. This part of the valley is called *Plauen-grund*, the deep dale of *Plauen*, from a village of that name at its entrance, so pleasantly situated, that it invites the inhabitants of *Dresden* to frequent walks. The rocks are here of *sienite;* and as far as can be judged amidst the disorder of their mass, their *strata* are strongly *inclined*, turning their planes towards the lower end of the valley; their irregular *sections* are seen above, interrupted by partial *subsidences*, which form small vales in a direction across the valley of *Plauen-grund* itself. Near the village of *Königsmühl*, on our right as we ascended this valley, M. Werner pointed out to me, in the rocks of *sienite*, two veins of *trapp*, which intersect them from top to bottom: researches have been made in these veins, with the view of exploring whether, farther on, they may not contain metallic parts; but none have been found.

427. Near *Postchapfel* there is a change in the nature of the rocks, which are here of the *porphyry*

that I had observed in passing over the same ridge of hills in my way to *Dresden*. Having crossed a branch advancing from this ridge, we entered a large basin, extending as far as *Döhlen*, and encompassed with rocks of *porphyry*: M. Werner made me remark the exterior aspect of this space, and gave me the following account of what lay below. There has been found, within this basin, a bed of *coal*, which is covered with *strata* of soft *foliated clay*; those nearest to the *coal* contain, as is usual, impressions of *vegetables*; and the *coal* itself, in some parts, exhibits *ligneous striæ*. On the side next *Postchapfel*, the bed of *coal*, rising against the *strata* of *porphyry*, is near the surface; but it lies at a greater depth on the side next *Döhlen*.

428. At some distance beyond this, we came to another basin formed by the retreat of the mountains on the left. The cultivated soil within this space rises in the centre like a cupola, and covers *strata* of *lime-stone*, which are worked by adits, that the product of the surface may not be lost. Though lime is made of this stone, it effervesces but little with acids; and it is remarkable, from containing masses of *jaspachates*, of various colours, especially red; in some of these masses, the *concentric strata* are of different colours. This is an interesting example of the *hard concretions*, various species of which have been found in *strata*, softer, and for the most part calcareous. The leading fact of this kind is that of the *flints* contained in *chalk*;

in many places, we still see these masses in the *strata* in which they were originally formed; but we find them disseminated in much greater abundance over soils of an extraneous nature, either in *gravel*, or imbedded in masses the ground of which consists of other indurated substances. Now different stones of the same class are found disseminated in both these ways; such as *agates*, *onyxes*, *calcedonies*, and *jaspers*. The beautiful *pudding-stones* in *Scotland* are aggregations of small *flints* of various fine colours imbedded in a very hard substance, but scattered in a *sand* which contains the same *flints;* and in the countries described in my former Travels along the course of the *Rhine*, great quantities of *agates*, *onyxes*, and other stones of of that class are also found under both these forms. Scarcely any of the latter stones are at present to be met with in the *strata* in which they were formed; but I have already shewn by characters analogous to those of the *flints* certainly belonging at first to *strata* of *chalk* which were dissolved in the ancient sea, though now disseminated in *gravel*, that all these different masses of the same class must also have been formed in *strata* of a *calcareous* nature. Now of this an example is afforded by the *jaspachates* contained in the *strata* of *lime-stone* which I have described above.

429. Beyond this place, the rocks on both sides of the valley consist of strata of a *breccia*, the ground of which is a paste of indurated clay, and

the extraneous masses, some of them not less than seven or eight inches in their mean diameter, are of *sienite*, *gneiss*, and other kinds of stones: most of the fragments of *gneiss* have remained angular; but those of *sienite* are rounded. These *strata* are about 10 feet in thickness; and their separations are strongly marked by the interposition of thin strata which do not contain any extraneous masses, and which being of different colours, their section looks like a ribbon striped with a dusky red and grey. From the valley, the *strata* of *breccia* on its sides are seen to incline, and to turn their *planes* towards its lower extremity; but there is in the valley a great recess on the right, the innermost part of which is cultivated; and on one of the sides of this recess, the rock being precipitously cut down from the height of nearly 100 feet, the sections of all these *strata* are exposed to view. The hill rises above, and is covered with woods, in which, for some way, we saw *blocks* of the *breccia;* but afterwards, without being able to observe the transition, we came to rocks of *gneiss*, or *veined granite*, as that in the *Alps* is called by M. de Saussure; it consists of the same component parts as *granite;* but the *mica*, remaining pure, forms in it distinct *strata*, alternating with other thin ones, in which the crystals of *feldspar* are mixed with those of *quartz*.

430. From this point, the valley turns to the west, and becoming narrower, leads to *Tharand*, a large village containing several very pretty houses, which

are hired, in the summer, by some of the inhabitants of *Dresden*, who either spend that season here, or come hither occasionally on parties of pleasure: they have however less need of making distant excursions into the country, than the residents in most other large towns; for *Dresden* abounds in very pleasant walks, as well within as without the walls; but as there is more variety in those at *Tharand*, they offer greater inducements to exercise in the open air; and on this account many invalids resort hither for the benefit of their health. The valley here divides into two branches; and at the point of the division, rises an insulated rock of *gneiss*, on which are the ruins of an ancient castle. The situation of this rock being very favourable for a belvidere, an easy path has been made up to its summit, around which benches have been placed in the vacancies of the arcades of the ancient walls; so that those who wish to enjoy the air may walk from one of these benches to another, resting themselves when they chuse, and viewing the country below under a great variety of aspects. The river arrives here by one of the branches of the valley, and along its course there is a shady path, continued up to the hill through a beech wood cut into alleys, which are also very agreeable walks. I found here an additional proof of what I have already so frequently shewn, that *vallies* have been produced, not by the *waters* which are now seen to flow in them, but by the *catastrophes* of the *strata;* for the hills bordering the left bank of the river consist of *por-*

phyry, while those on the right bank are of *gneiss*.

431. M. and Mad^e^ VON MANTEUFELD, who were passing the summer at *Tharand*, being acquaintances of M. Werner's, were so good as to conduct us to a walk made in the upper part of the hills of *porphyry*, and continued along their brow, which commands a view of all the neighbouring country. The soil on these hills is cultivated; it is of considerable depth, and contains *gravel* of several kinds of stones extraneous to the hills themselves; among the rest, of *flints*. In this walk, we were joined by M. ROUGEMONT, a French ecclesiastic, who happened to be also at *Tharand;* he had amused himself by making a collection of these stones, which he shewed us on our return; and it was really a very remarkable one, from the great variety of their genera and species. Among the *flints*, he had some echinites similar to those which are found in the *strata* of *chalk* now existing; but no such *strata* are met with in these countries. The *sand* containing this gravel covers, in some places, *strata* of *sand-stone*, in which M. Rougemont had found *marine bodies;* among others, some *ostreæ*. Here then is a vast variety of geological phenomena, all presented by a single valley, within a space of only three leagues; and to these I could add many other interesting particulars, if I did not fear to be too tedious. We returned to *Dresden* at seven in the evening.

June *7th.* I set out from *Dresden* with M. Werner, at seven in the morning, for *Freyberg*, where we arrived in the afternoon. The first part of our road lay over the same hills as we had observed the day before, leaving the valley of *Tharand*, which intersects them, on the left. We crossed the ridge of *sienite*, whence, after a slight inflexion, we arrived on that of *porphyry*, near the point where it encompasses the bed of *coal* over which we had passed in our way to *Tharand;* hence, also, we saw at a distance the places where the *lime-stone*, farther up in the valley, is burnt into lime. Turning then more to the right, we saw, on the tops of some of the hills, masses of *strata* of *sand-stone*, some of which are mingled with *argillaceous*, and some with *calcareous earth;* but both kinds contain *marine bodies*, particularly the same *ostreæ* that are found in the valley of *Tharand*. M. Werner pointed out to me, on several other summits, masses similar to these; and he called them *hats*, because they are broken off all around, and are observed only in elevated situations. Since these *strata*, however, contain *marine bodies*, they must have been originally continuous on the bottom of the sea; they are covered with a *loose soil* participating in their nature; and they have beneath them *strata* of *gneiss:* the latter are seen in several clefts, where they shew, by their inclinations, that they had undergone some of their catastrophes, before those of *sand-stone* were formed upon them; but since that period, both these kinds of strata have suffered together much greater catastrophes, in consequence of partial *subsi-*

subsidences, and have thus been reduced to the state in which we see them, with these *hats* of *sand-stone* remaining on the summits.

432. As we were passing over an eminence, M. Werner shewed me at a distance the district of *mines* belonging to *Freyberg*, of which the appearance much surprized me. I had seen in the *Alps* and in the *Hartz veins* of the same kind as those of this district, but always in wild and desert regions studded with projecting rocks, where torrents rush down between mountains cloathed with forests of firs; so that I could not, without astonishment, contemplate this country which, though so famous for its veins, externally consists of cultivated hills under the most softened forms, and exhibits to the eye no sign of the *mines* contained within, except the *haldes*, or heaps of the refuse stones taken up out of the shafts, and near these heaps, the small houses belonging to the machines. M. Werner did not wonder at my surprize; for he told me that, though similar *veins* had been worked for many centuries in the neighbouring countries, those in the district which lay before our eyes shewed themselves so little by any exterior signs, as to have remained unknown till the year 1140; and that even then they had been discovered by accident. A waggoner belonging to *Goslar* in the *Hartz*, who had been frequently employed, in that chain of mountains, in carrying ore of *galena*, happened to pass over the hills of *Freyberg;* where perceiving *galena* in some of the scattered stones, he

comprehended that these were masses of *gangue*, and had no doubt that a *vein* must lie beneath the loose superficial soil. Going back to the *Hartz*, he imparted his discovery to some skilful miners, who returned with him to the spot; where having carried on some farther researches, which convinced them that a *vein* really lay here, they solicited and obtained the privilege of exploring and working it. Such was the origin of the *mines* in this country, where several other *veins* have since been discovered, and worked with great profit.

433. The town of *Freyberg*, where we arrived at three quarters after five, is well built, and agreeably situated in a vale; on one side it is encompassed by a brook, which flows through meadows, and is bordered with walks: in these walks, and afterwards in the town, I saw some of the miners, who were cloathed in the uniform which they wear above ground, and were all very neat. M. Werner was so good as to lodge me in his house; a situation the more advantageous to me, because of his immense collection of minerals, on which, as Professor of Mineralogy in this college, he delivered lectures to the students.

June 8th. M. Werner conducted me to an eminence near the centre of the district of the *veins;* this district is eight leagues in length by two in breadth, and includes within it several hills, of which the inflexions are much softened by a great depth of loose soil, every where cultivated, and very fertile. Beneath this soil lie *strata* of *gneiss*, which are so much broken and disordered, that they frequently change both *inclination* and *direction*. This whole tract is intersected by *veins*, of which the richest part consists of *silver*, differently mineralized; but almost all other metals and semi-metals are likewise found here, in gangues of *spar* of all the three species, *calcareous*, *fluoric*, and *barytic*. The principal *veins* follow nearly the same direction; but they frequently divide, and are intersected by many other *veins* which have different directions.

434. One of my principal objects in coming to *Freyberg* had been to discourse with M. Werner on our common idea, that *veins* were originally *fissures* in the mass of the *strata*, which had been gradually filled with their *gangue* by precipitations against their sides, while still under the waters of the sea. Against this system had been brought a plausible objection, to which I had replied in the *Journal de Physique* published by M. DE LA METHERIE; but I was very glad to have an opportunity of observing, with M. Werner, some of the phenomena which had determined his opinion, in order to compare them with those whence I had drawn the same conclusion.

435. The above objection had been taken from certain *veins* in mountainous regions, so much *inclined*, and at the same time so *wide*, that, had they

ever been empty while in this state, the highest part, or *roof*, must have fallen down on the lowest, or *wall*. This objection, which is of equal force against the system where *veins* are supposed to have been filled with substances injected, while in fusion, from below, was intended to support that of the formation of *mountains*, with their *veins*, in the state wherein they are at present found; a system contradicted by all the descriptions which I have heretofore given of *mountains*; but it was neccessary that this objection should be fully refuted, and I had found the task very easy. The *fissures* produced by the earliest catastrophes of the *strata* were nearly *vertical*; and it was in this situation, that those now converted into *veins* were filled with their *gangue*. But the *strata*, since that time, have repeatedly undergone greater catastrophes, in which, the *veins* being included, they have been *broken*, and some of them have assumed a strong inclination, together with the *strata* that contain them; and this is the state in which we at present find them.

436. On this subject, M. Werner supplied me with an immediate proof that the *veins* within each particular district are not all of the same *date*; some of the *veins* here had been already filled with their *gangue*, when fresh catastrophes produced new *fissures* which passed across the former, yet still at so early a period, that the latter *veins* were filled with nearly the same *gangue* as the others; but the *gangue* of the latest is *continuous* and uninterrupted,

while it *cuts* that of the preceding; and hence their comparative dates are known. The same is observed in all the intersections of the *veins*, which, in this district, are very numerous. These fissures, produced at various epochs, shew likewise that the *subsidences* wherein they originated did not all take place in the same line; and this is the cause of the different *directions* and *inclinations* of the *strata* themselves.

437. Another proof of these catastrophes results from a comparison of the opposite sides of the same *veins*. For when the whole mass of the *strata* has been intersected by the fissures in such a manner that a continuous *gangue* has been formed in the latter down to the greatest depth which can be reached, the two parts of the divided mass having thus been left free to yield separately to the power of gravity, they have, in general, subsided more on one side than on the other; so that the same *strata* (which may easily be recognized) are sometimes found at very different levels on the opposite sides of the same continuous *vein*.

438. The formation of *vallies* results from the same general cause, but has been every where attended with greater *angular motions* of the masses divided by *fractures;* in most instances, with a double *fracture*, and the *subsidence* of the intermedial mass, either throughout the whole length of the valley, or in some of its parts, which has occa-

sioned the great inequalities of breadth so common in *vallies:* the same differences of level in the strata may therefore be remarked on the opposite sides of a valley, as on those of a vein; but besides, on account of the great vacancies, or spaces left free for the angular motions of the *strata*, the sides of the vallies exhibit also the same differences of inclination and direction, which we find in piercing to the greatest depth in the *strata* in *hills* and *mountains.* The small river *Mulda*, very useful in the labours of the mines, and in the transportation of the ore, here flows in a narrow *valley;* and in the sides of this *valley*, M. Werner made me observe several little *veins*, which, having been broken in the catastrophe whence it resulted, must evidently have been formed in *fissures* anterior in date to its formation: many of these *fissures* unite below in a single one. In the part here exposed to view, the *gangue* consists chiefly of *spar*, and contains nothing metallic; but when the small *veins* thus collected together in a single fissure are followed to a greater depth, ore is found in some of them.

439. It was in the sides of this valley, that M. Werner pointed out to me the principal phenomenon which had convinced him that *veins* were fissures filled up with substances precipitated against both the sides of the space thus opened; and this phenomenon was precisely the same which had led me also to that opinion. In all *veins* these new substances have on both sides been deposited in symmetrical

layers; and the interval between them having been gradually narrowed by their accumulation, they have at last united towards the middle, where, however, there still remain some vacancies lined with small crystals. Now in the little *veins* just described, M. Werner shewed me a remarkable circumstance, which at once proved the symmetrical accumulation of the substances on the opposite sides of the fissures, and the catastrophes undergone by the *veins* after the reception of their first gangue. These *fissures* have evidently been enlarged by a new subsidence of the *strata,* which has been more considerable on one of their sides than on the other; and which has divided the first gangue, in many places along the line of its central junction; the same operation has then recommenced on both the sides of the new fissure thus produced; and symmetrical *layers,* uniting incompletely towards the middle, have again been formed in the same manner as before. This is a case which is frequently observed in large *veins,* where new fissures have taken place, sometimes towards the middle, sometimes on one of the sides, and where the unequal progress of the accumulations on the opposite sides is shewn by effects on a greater scale, especially by large cavities, always lined with crystals, like that which I have described at *St. Andreasberg,* in the *Hartz,* § 185.

440. In order to shew me the direction of the principal *veins,* M. Werner first led me to the mine of *Freudenstein,* which had been abandoned, and

afterwards to another, called *Komm-sieg-mit-freuden;* in the latter, as we walked along by the side of the abrupt rocks, he made me remark a mass of *strata* of *porphyry*, which were thick, and intersected those of *gneiss* with a greater inclination inwards; and as these *porphyric strata* are found at different depths beneath the surface, they shew, by the *fractures* which they have suffered together with the *gneiss*, what a succession of catastrophes all the the *strata* have here undergone.

441. In our way from hence to the mine *Isaac*, we stopped at a place remarkable for the ingenious manner in which the *Mulda* has been made to serve in the transportation of the ore and the refuse stones taken out of the mines. In common seasons, there is so little water in this river, that, in parts where its slope has any rapidity, it flows among stones, on which it may easily be forded. This is the case here for a considerable way; and in order to remedy the inconvenience, a *canal* has been cut along one of the sides of the valley, for the passage of the small boats laden with stones or with ore; this brings them to a point, below which the river becomes navigable, and at which sluices might have been supposed necessary to carry down the boats: but the valley is so narrow, that this expedient would have been attended with great expense; and the following has therefore been adopted in its stead. About a boat's length from the extremity of the *canal* begins a covered bridge, which is firmly supported by

pillars across the valley, and terminates vertically above the part of the river intended to receive the boat. Under this bridge are placed two beams, at such a distance as to allow a sufficient space for the boat to pass, when suspended between them. A windlass is moved along them by a wheel, the teeth of which fit into a *rake* fixed on one of them. When a boat comes down the canal, this windlass is brought to the beginning of the bridge, and by means of ropes it raises the boat to a sufficient height to pass over the wall which terminates the canal; the windlass then, its handles being fastened, is moved along the *rake* by means of the wheel, and carries with it the boat thus suspended, till the latter is brought above the navigable part of the river, into which it is then let down. By an inverse operation, boats are made to ascend from the river into the canal.

442. Hence we proceeded to the village of *Grosse Schirma*, near which is the mine *Chur-Printz Friederich August*. I saw here one of the largest shafts, on the western extremity of the principal *vein* called *Halsbrücker-gang*, where every thing belonging to the mechanical part of the works appeared to me to be executed with the greatest simplicity compatible with the different purposes which it is intended to effect. The direction of this vein is nearly from N. E. to S. W. with some deviations in its branches; and as it has been worked for a long time, and is now carried down to a great depth, the

wood of the props in the upper part has decayed; which has occasioned subsidences to a great extent, and has thus produced at the surface a kind of small *valley*, shewing the course of the *vein*, and of several of its ramifications, the sides of this valley, now open to view, being those of the original *fissure*, in which was formed the *gangue* that has been extracted.

443. In the afternoon, M. DE CHARPENTIER, a counsellor of the mines, was so good as to invite me to see the buildings for the *amalgamation* of the ores, of which he had superintended the erection, and now directed the works, on the plan of Baron VON BORNE in *Hungary*; and the Polish General, Count DE KOMMARSCHESKY, who had been for some time settled at *Freyberg*, and was very well acquainted with all the labours of the mines, very kindly accompanied me to this gentleman's house, near the place where the buildings stood. I admired the construction and arrangement of all the machines, the operations of which were carried on by a small brook led to the centre of the buildings; but I must here content myself with giving a general idea of the object, and of the process for effecting it, which are very interesting in *docimastics*; (i. e. the art of extracting *metals* from *ores*.)

444. Some *ores* are too poor to defray the expense attending the process of extracting their *silver* by the common mode of smelting; and it is

for

for these that the operation in question has been invented; but for this purpose, they must be mixed, in a certain proportion, with richer *ores*: since, however, all the processes of this operation require te be carried on upon a large scale, and cannot conveniently, therefore, be conducted by private persons, the Elector takes the whole on himself; and the owners of the different mines, having caused the gangue of the *veins* to be stamped and washed, sell it to him at a price determined from two assays, one by themselves, the other by persons of his own appointment. The masses brought in for this operation are always of considerable bulk, and are separately placed under a large shed, where every heap is distinguished by a small piece of wood, on which is marked the quantity of *silver* contained in each *quintal* of *ore*; some ores are so poor as to contain only half an ounce of *silver* per quintal; but others have not less than 15 ounces. The quantity found most suitable to the economy of the operation is 3½ ounces per quintal; and this is obtained by mixing together different ores in the proper proportions. The ores thus mixed are placed under another shed, and their mass is then subjected to the following process.

445. Alternate layers are first made of the *ore* and of *sea-salt* in a certain proportion. A regular heap is thus formed, to a certain height, at the end of the shed, on one side; and it is worked together, in order to mingle the *salt* completely with the *ore*; this is effected, by cutting the first heap ver-

tically in slices, and laying them near it, one on another, to make a second, which is cut in the same manner; and this process is repeated several times, till the last of these successive heaps is near the door at the other end of the shed: at the same time another heap is going through a similar operation o the other side; so that, when one of these is take out, the second is ready to follow it; and thus i succession.

446. This mixed mass is then carried into th building where it is to be *torrefied*, and where ther are four *ovens* for this purpose, one on each sid Each of these *ovens* has two iron doors in front, an another on the right side. By the front door on t left, which is that of a *reverberating furnace*, wo is thrown in, and its flame rises to the middle of t cavity, where the ore is *torrefied*. The mixtu being then introduced by the other front door, dries, and when heated, it is pushed on, with an ir rake without teeth, into the part to which the fla extends; and during the torrefaction, it is incessant stirred with a rake with teeth, a similar quanti being at the same time introduced into the pa which it had occupied at first. The manager of t oven knows by the appearance and smell of the mas when it is sufficiently *torrefied;* and he then dra it out, with the rake, without teeth, into an ir chest on rollers, in which it is transported to a di ferent part of the building, where it is left to coo if, on being first taken out of the oven, it is viewe

in the shade, it exhibits some degree of incandescence. When the matter has cooled, it is pounded and sifted by a very expeditious process, and is then ready for amalgamation.

447. The final effect of this first operation consists in the combination of the *silver* with the *acid* of the *sea-salt*, with which it forms the *luna cornea;* and it is from this combination that the silver is afterwards withdrawn by mercury. But what had passed previously to all this? Had the *silver* existed as silver, having been *mineralized*, according to the common opinion, by other substances? Or had there existed in the *ore* only the ingredients proper for forming *silver* by the processes here employed? I incline to the latter opinion; but it would take up too much time to detail my reasons, since they would lead me to a great depth in chemical operations; I therefore confine myself to the simple mention of it. The chief ingredient of the ore is here *sulphur*, the *acid* of which, during the *torrefaction*, combines with the *alkali* of the *sea-salt;* the latter having yielded its own *acid* to the *silver*. When the ore is found to be too much impregnated with *sulphur*, it is mixed with *iron*, which carries off the excess of its *acid*.

448. The *amalgamation* is performed in a separate building, in small turning barrels, each having a door which closes very exactly, and by which is introduced the pulverized matter, with *mercury* and

water in the proper proportions. Ten of these barrels are turned by the same machine; but each may be separately stopped, for the purpose of examining the progress of the operation, which consists in the following process: the *water* combines with the *muriatic acid*, proportionally as the *silver* amalgamates with the *mercury;* and the state of the *water* shews when the operation is terminated. The barrel is then emptied, and the greater part of the mercury is immediately collected at the bottom of the vessel which receives its contents; but a considerable quantity remains suspended in small globules in the turbid water: this water is then poured into a *washing-mill*, at the bottom of which there is an iron cross, turning in a basin of the same metal; this collects around it the globules of mercury, and they are afterwards added to the rest. The mercury is then passed into a straining bag, where the part which is not strongly amalgamated runs off; this part, indeed, contains some portion of *silver*, but as it is again repeatedly used for the same purpose, all is at last recovered. As for the mass of *amalgam*, it is managed in the following manner.

449. From the bottom of an iron basin, rises a shaft of the same metal of a conical form, on which are filed iron cups with tubes in their centre: each cup is of smaller diameter than that below it: and as their tubes diminish in the same proportion, they are stopped on the shaft at certain distances by the increase in its size. In these cups is placed the

amalgam: and the basin below being filled with water, the pyramid is covered with an iron bell, the edge of which includes within it that of the basin. A fire of peat being then kindled around the bell, the heat occasions the evaporation of the mercury, which is afterwards found in the water of the basin, where its vapours are condensed. The *silver* remains in the cups, but combined with other *metals* and *semi-metals*; it therefore still requires to be *coppelled*. For this purpose, a certain quantity is collected together, and is placed in the coppel with lead containing silver, the result of other smeltings; which silver is now extracted, together with that of the amalgam. All these operations are carried on with so much order and facility, that they are continually commencing at one extremity of the buildings, while, at the other, they are terminating in the coppel; and every mass of the pulverized ore goes through all these different processes in 24 hours.

June 5th. I set out in the morning with M. Werner on a new excursion; when he conducted me first to the houses of the mines called *Beschert-glück-hinter*, *Kuhs-schacht*, and *Rücken-schacht*, belonging to the veins of which he showed me the directions, and described to me the characters. This road led us to the highest spot in the whole district of these mines, known by the name of the *Three Crosses*; it being what, on the continent, is called a *Calvary*. From this spot, which is seen from a great distance all around, I could more particularly observe the striking dissimilarity between the exterior aspect of the country, and what is known of its interior state; the former presented only hills with softened outlines, then covered with the finest harvest; while beneath this cheerful surface lay a region, which I could not but represent to myself as inhabited by a nation of *Gnomes,* occupied down to a great depth, in opening new paths in darkness. This high district is called *Hohe-bircker-retier.* Hence M. Werner shewed me, as traced by the *haldes* and the buildings belonging to the mines, the directions of four large *veins,* extending, with some inflexions, the whole way from the town of *Brand* on the S. E. to the small valley of the *Mulda* on the N. W. a direction which cuts, almost at right angles, that of the principal vein, the *Halsbrücker gang.* There are, in this district, many smaller *veins,* intersecting each other in every direction.

450. With respect to the *strata* appearing externally, M. Werner first led me to a quarry in a mass of *gneiss,* the surface of which had a very brilliant appearance, from the splitting off of large thick flakes in the direction of the *strata,* and along the line of those of *mica.* In this mass, the *strata* were nearly horizontal; but in others they are more or less inclined. He afterwards shewed me a large mass of *strata* of *white quartz,* containing parallel streaks of *mica.* I particularly mention these *strata* of *white quartz,* which here appear at the

surface among those of *gneiss;* because there have been seen in this journey, and will be described in the following, hills of *gneiss* and of *schistus* overspread with *blocks* of the same *quartz*, though none of their exterior *strata* consist of that stone; a phenomenon which is not confined to *Germany* alone, for I have seen it also in *Cornwall*.

451. I should very gladly have profited longer by the opportunity of acquiring so much information as, in this country, and under the auspices of M. Werner, I could not fail to obtain; but my time was limited by the long excursion in which I was engaged; so that, after having taken this last general view of the mining district, I quitted *Freyberg*, at 3 o'clock, on my return to *Dresden*. M. Werner gave me a recommendation on the road to the director of the mine *Himmel-fahst*, the *halde* of which being raised to a great height, he advised me to ascend it, as I accordingly did. Hence I had a view of the country, comprizing, from the *Three Crosses*, the whole of the mineral district. As I followed with my eye the line of the *haldes*, this district appeared to me to be terminated on the east by a deep inflexion of the surface across the road along which I was to travel; for I saw *haldes* as far as that inflexion, but no indication of any mines appeared beyond it. Along this line, therefore, a stop has been put, by a great fracture of the strata, to the *fissures* in which have been formed all the *gangues* hitherto described. These great superfi-

cial *intersections* of the strata frequently converge and join, like the *fissures* containing veins in the interior part of the ground: the valley which is here formed, and through which the small river *Bobritsch* arrives from *Frauenstein*, meets that of the *Mulda* at *Siebenlehn* below *Freyberg*. So long as it was light, I observed in the loose soil on my road *blocks* of *granite*, *sienite*, *gneiss*, and *white quartz:* most of the *blocks* of the two former species had their angles rounded; but this was not the case with the others; a difference of which, in the sequel, I shall take occasion to explain the cause. I arrived at *Dresden* at nine in the evening.

June 10*th. and* 11*th.* I staid these two days at *Dresden*, and the last of them was employed in a very interesting manner. My late respectable friend, Count VON BRUHL, the Saxon Envoy in *London*, had given me recommendations to M. VON GUTSCHMIDT, Minister of State at *Dresden*, and to Count MARCOLINI; and the latter of these gentlemen, who was grand Equerry to His Electoral Highness, was so obliging as to offer to present me to Him at *Pilnitz*, whither he accordingly took me on the 11th, together with the Inspector Keuler, whom I have already mentioned. His Electoral Highness most graciously permitted me to pay Him my respects; an honour which I shall always remember with peculiar satisfaction, the sentiments then expressed by that virtuous Prince having made a deep impression on my mind.

452. I afterwards accompanied M. Keuler to the *Borsberg*, an eminence belonging to a small chain of granitic mountains, which here follows the *Elbe* at some distance, but retires farther from the river at a higher point of its course. The top of the *Borsberg* commands so extensive a prospect, that the Elector has been induced to erect on it a belvidere. It is impossible to imagine a country more cheerful than that within view from this spot, on account of its rich cultivation, and the almost innumerable multitude of towns and villages, which may be seen to as great a distance as the eye can reach; and the latter circumstance had suggested to M. Keuler a very ingenious idea. The *Borsberg* is separated from the rest of the chain by a very deep valley, the bottom and sides of which being covered with fir-trees interspersed among rocks, I could almost have taken it for one of the vallies of the *Alps*. The upper part of the eminence thus insulated consists of a prodigious heap of large *blocks* of *granite;* and between these there is a path up to the summit, which has been levelled to form an esplanade, and is surrounded with a rail. In the centre of this space, M. Keuler has caused to be placed, on a solid foot, a horizontal brass table, on which rises a a small spike to indicate the summit of the hill itself. Against this spike is brought a brass ruler, whereon is placed a telescope moved up and down, which he has directed successively to all the towns and villages within the compass of this horizon, tracing on the table their respective visual lines, and causing

the names of the places to be engraven on these lines, at proportional distances from the center. These names cover the whole table, which is thus converted into a very interesting topographical map; so that any person, standing before the central point, may become acquainted with all the places which are within his view.

453. The *blocks* heaped up on this eminence, where art has interfered only to arrange them on the summit in a platform, constitute a new example of the great phenomenon which I have already described in some places, and shall again have occasion to mention in the sequel; a phenomenon absolutely contradictory to the hypothesis that the *blocks* scattered over countries far remote from all mountains have ever *migrated* on the surface of the continents: for before such an idea can be entertained, it is necessary to explain by what cause *blocks* can have been thus raised up in heaps on the highest parts of the mountains. I have already repeatedly stated the cause to which they must every where be referred, and which alone agrees with all the phenomena attending them; I mean their ejection from within, during the violent catastrophes of the *strata*, in those very places where we at present find them, whether low or high. There is no other cause which can be substituted in the room of this, as capable of accounting for any of the examples, hitherto given, or still remaining to be described.

END OF VOL. I.

INDEX

TO THE

PLACES MENTIONED IN THE FIRST VOLUME.

A.

AAR R. § 129.
Aix-la-Chapelle, § § 248—258.
Aller R. § § 285, 286, 288, 398.
Alps M. § § 5, 13, 16, 20, 84, 124, 128, 129.
Alster R. § 298.
St. Andreasberg M. § § 173, 177, 181—187.

B.

Barnewitz, § 408.
Baruth, § 421.
Bederkesa, § § 277, 289, 291.
Berlin, § § 309, 331, 407, 409—414, 421.
Besançon, § § 142—144.
Bied R. § 36.
Bienne L. § § 85—90, 124, 126, 128—130.
Birse R. § 122.
Blanckennes, § § 299—301.
Blankenburg, § § 368, 377, 379—388.
Blocksberg M. § § 174, 176, 177, 368, 373, 377, 388, 389, 395, 396 a.

Boudeviller, § § 98, 101.
Boveresse, § 31.
Bremer-Vohrde, § § 277, 289.
Brenets, § § 67, 70.
Brevine, § § 58 *a*, 60, 63, 64, 104.
Bruchberg M. § § 174—176.
Bruges, § 264.
Brunswick, § § 342, 368, 397—400.
Brussels, § § 262, 263.
Burgdorf, § § 341, 342.
Butzbach, § § 229, 230.
Bützow, § § 330, 331.
Buxtehude, § 309.

C.

Calais, § 269.
Cassel, § § 221—223.
Catlenburg, § § 345, 356.
Cattenbül M § § 196—201.
Chasseralle M. § § 96, 119, 124, 131.
Chasseron M. § § 27, 80.
Chatelar M. § 71.
Chateleut M. § § 64—67.
Chaumont M. § 137.
Chaux d'Etalières, § § 58 *a*, 60.
Chaux de Fond, § § 103, 107—109, 114—117.

Cologne, § 248.
Convers, § § 115, 118.
Couvet, § § 30, 31, 36, 37, 41, 46, 57, 79, 81.
Cramont M. § § 13, 16.
Crautz, § § 301, 302.
Creux du Vent, § § 45 *a*, 46, 48, 50, 56, 140.
Cuxhaven, § § 274—277.

D.

Darmstadt, § § 237—242.
Dazenet, § § 105, 114.
Deister M. § § 162, 163.
Dijon, § 145.
Dole, § § 144, 145.
Dombresson, § § 99, 101.
Dorstedt, § 397.
Doux R § § 65, 67—69, 103, 105—107, 114, 124, 141, 142.
Dransberg M. § § 193, 194.
Dransfeld, § § 193—195.
Dresden, § § 423—426, 451.
Dritgeest, § § 277—279.
Dunkirk, § § 264, 265, 267—269.
Dusseldorf, § § 150, 151.
Düvelsmaur, § 387.

E.

Ecker R. § § 395—398.
Eder R. § 224.
Einbeck, §§ 342, 343.
Elbe R. § § 274—277, 282, 287, 298, 299, 301—304, 309, 310, 312—316, 318, 323—327, 400, 403—407.
Elsterwerda, § 423.
Esbeck, § § 166—169.
Etalières L. § § 60—62.

Flotbeck, § 300.
Frankfort, § 235.
Freyberg, § § 432—451.
Fulda R. §§ 195, 215, 224.

G.

Gardeleben, § § 401, 402.
Ghent, § 263.
Giant's mountains, § § 417, 423.
Gorgier, §§ 53—56.
Göttingen, § § 191, 345, 356.
Gros-Almerode, § § 203, 216, 217.
Grossen-Hayn, § 423.
Grund, §§ 171, 345—347, 349, 351.

H.

Hagenburg, § § 332, 333.
Halberstadt, § § 375—377.
Hamburg, § § 297, 298.
Hameln, § § 364—366.
Hammersleben, § 374.
Hanover, § § 160—162, 287 *a*, 288, 332, 340—343, 356.
Harborg, § § 314—316, 318, 323.
Hartz M. § § 161, 170—180, 342, 343, 345—356, 367

Heinburg M. § 191.
Helmstedt, §§ 369—372.
Hertzberg, § 189.
Hildesheim, § 347.
Hittefeldt, §§ 155, 156.
Holtzdorf, § 227.
Holzemme R. §§ 389, 390.
Hornburg, § 316.

I.

Ilse R. §§ 389—391, 393.
Ilsenburg, §§ 368, 389—395.
Ilsenstein, §§ 394, 395.
Innerste R. §§ 347, 350.

J.

Joigny, § 145.
Jura M. §§ 5, 10, 11, 23—145.

K.

Kettenborg, § 284.
Königslutter, § 368, 369.
Kyritz, § 330.

L.

Lahn R. §§ 227, 228.
Lasfeld, § 352.
Lauenburg, § 312.
Lauenstein, § 363.
Lautenthal, § 350.
Leine R. §§ 162, 165, 169, 191, 343—345, 347.

Luckau, § 421.
Lühe R. §§ 275, 276.
Lunenburg, §§ 318—321.

M.

Marburg, § 227.
St. Martin, §§ 99—102, 112.
Meisner M. §§ 161, 196, 207—216.
Mellendorf, §§ 286, 288, 289.
Mentz, § 242.
Mittenwalde, § 421.
Moselle R. §§ 245, 246.
Motier-Travers, §§ 31—33, 35—37, 46.

N.

Neuenwalde, §§ 277, 292.
Neufchatel, §§ 86, 90, 131, 136, 138.
———— L. §§ 27, 84—88, 101, 129—131.
Neuville, §§ 130, 131.
Noiraigue, §§ 47, 48, 51, 75, 77, 83.
Nordheim, § 345.

Osnaburg, § § 150, 152—155.
Oste R. § § 282, 305—307.
Ostend, § 264.
Osterode, § § 347, 353—356.
Osterwalde, § § 357, 359—363.

P.

Paris, § 145.
Perleberg, § § 329, 330.
Peseux, § 101.
Pierrenoud, § § 32, 33.
Pierre Pertius, § § 121, 123.
Pilnitz, § § 451—453.
Plauen-grund, § § 426—429.
Pontarlier, § § 23, 141.
Pont-Martel, § § 77—79.
Potschapfel, § § 426, 427.
Pyrmont, § § 163, 164, 366.

R.

Rathenau, § § 406, 407.
Regenstein, § § 387, 388.
Rehberg M. § § 178—180.
Rehburg, § § 333—339.
Reuse R. § § 29, 31, 36, 37, 45—49, 52, 63, 79—85, 139, 140.
Rhine R. § § 27, 242—248, 265, 266.
Rhone R. § 27.
Ritzenbuttel, § § 277, 291, 296.
Robelsberg M. § § 217—219.
Roche-fendue, § § 70—72.
Rosse-trap, § § 381—386.
Rotenburg, § § 284, 289.
Rüdersdorf, § § 414—417.

S.

Salève M. § § 134, 135.
Schnee-koppe M. § 423.
Selfingen, § § 281, 282, 289.
Serrière, § 101.
Seyon R. § § 86, 90, 95, 96, 100, 101, 136.
Sieber R. § § 182, 186—189.
Sonceboz, §§ 119, 121, 123.
Sonnenwalde, § 422.
Söse R. § § 345, 347, 354, 356.
Spandau, § § 407, 409.
Spree R. § 407.
Stade, § § 282, 305, 323.
Steimke, § § 400, 401.
St. Sulphi, § § 28, 31, 46, 79.
Suze R. § § 115, 118, 119, 123—126, 129.

T.

Tangermünde, § § 402, 403, 405.
Tête-de-rang M. § § 98, 101.
Tharand, § § 430, 431.
Travers, § § 31, 45, 46 *a*, 52, 82.

U.

Unkelbach, § 247.

V.

Valangin, § § 91, 95, 98.
Val-de-la-Sagne, § § 51, 74—79, 95, 98, 108.

Val-de-Rus, §§ 74, 86, 91, 93, 95—102, 136.
Tal-de-Tavanne, §§ 121, 122.
Val-de-Travers, §§ 27—31, 41—52, 56, 58 *a*, 78—82, 90, 100, 139.
Valorsine, §§ 13, 14.
Val-St.-Imïer, §§ 115—123, 127.
Verrières de Joux, § 27.

W.

Walsrode, §§ 284, 285, 289.
Wawern, § 224.
Wegeleben, § 375.
Wernigerode, §§ 368, 388—390.
Werra R. §§ 195, 215.
Weser R. §§ 163, 195, 215, 274, 363—366, 398.
Wiedelah, §§ 395, 396 *a*.
Wildeman, §§ 347, 348, 350.
Wittenburg, §§ 356, 357.
Witzendorff, §§ 157, 158.
Wolfenbüttel, §§ 397—399.
Wustermarck, §§ 408, 409.

Z.

Zarrendorff, §§ 156, 157.
Zell, §§ 158, 159.
Zierenberg, §§ 232—235.
Zöllen-Spicker, §§ 313, 314.

THE END OF VOL. I.

Printed by Law and Gilbert, St. John's Square, London.